10th Global Symposium on Millimeter-Waves (GSMM 2017)

Final Program and Book of Abstracts

24-26 May, 2017 City University of Hong Kong, Hong Kong

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10th Global Symposium on Millmeter-Wave (GSMM 2017)
24-26 May, 2017 Hong Kong, China

http://gsmm2017.cityu.edu.hk/

General Co-Chairs' Message

Welcome to the 10th **Global Symposium on Millimeter-Waves (GSMM 2017)**, which will be held in Hong Kong on 24-26 May 2017. The main theme of GSMM 2017 is Millimeter-Wave and Terahertz Sensing and Communications. It covers millimeter-wave and THz antennas, circuits, devices, systems and applications.

It is organized by the State Key Laboratory of Millimeter Waves (Partner Laboratory in City University of Hong Kong), financially co-sponsored by Shenzhen Softinfo Technology Co., Ltd, Virginia Diodes, Inc., and Anritsu (China) Co., Ltd., and technically sponsored by IEEE Microwave Theory & Techniques Society.

Aside from joining the symposium, please also enjoy your tour in Hong Kong. Hong Kong, a metropolis of 7 million people, is one of the most popular tourist destinations. It offers cultural diversity, natural beauty and incredible skylines. We guarantee you a memorable experience for your choice of either hiking in a nearby outlying island or shopping in a magnificent mall, followed by a meal at one of the Michelin restaurants ranging from a few US dollars to a couple of hundred dollars.

The Organizing Committee looks forward to meeting you and making your visit a memorable and delightful one.

See you in Hong Kong in May 2017!

Sincerely,

Chi Hou Chan and Quan Xue
General Co-Chairs
10th Global Symposium on Millimeter-Waves

Organizing Committee

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Organizer

CityU
香港城市大學
City University of Hong Kong
專業 創新 胸懷全球
Professional·Creative
For The World

毫米波國家重點實驗室
State Key Laboratory of Millimeter Waves
（香港城市大學夥伴實驗室）
（Partner Laboratory in City University of Hong Kong）

Technical Sponsor

IEEE

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Financial Sponsors

About GSMM

The Global Symposium on Millimeter-Waves (GSMM) is an annual forum for researchers, engineers and practitioners to present and discuss recent breakthroughs, innovations and emerging techniques in field of millimeter-wave and terahertz sensing and communications. GSMM2017 is the continuation of a series of annual global millimeter-wave and terahertz symposiums held in Nanjing, China (2008), Sendai, Japan (2009), Seoul, South Korea (2010), Espoo, Finland (2011), Harbin, China (2012), Sendai, Japan (2013), Seoul, South Korea (2014), Montreal, Canada (2015) and Espoo, Finland (2016).

The symposium is organized by the State Key Laboratory of Millimeter Waves, Partner Laboratory in the City University of Hong Kong, technically sponsored by IEEE MTT-S.

General Information

Venues
The conference venues are located in Li Dak Sum Yip Yio Chin Academic Building, City University of Hong Kong. It is only 45 minutes by rail from China as well as the Hong Kong International Airport.

Weather
Typical temperature in May is around 26°C with an average of 158mm of rain and high humidity.

Currency
The local currency in Hong Kong is the Hong Kong dollar (HK$), which is one of the most traded currencies in the world. The value of the Hong Kong dollar has been pegged at HK$7.8 to the US dollar, and consequent rates of exchange to other currencies. However, the market rate exchange to the US dollar fluctuates marginally.

Bank notes are issued by HSBC and Standard Chartered Bank have denominations of HK$10, HK$20, HK$50, HK$100, HK$500, and HK$1,000. The Bank of China issues all of the above denominations except HK$10. Coins are bronze-coloured for 10 cents, 20 cents and 50 cents, silver-coloured for HK$1, HK$2, and HK$5; nickel and bronze for HK$10. All coins are issued by the government.

Major credit cards are accepted in most hotels, shops and restaurants.
Traveller cheques and foreign currency can be exchanged at hotels or banks.

Octopus card
The Octopus card is a stored value electronic card widely used in Hong Kong for public transport, purchases in convenience stores, fast food shops, supermarkets, cake shops and vending machines, etc. You simply place the Octopus card over a reader, and the correct amount is deducted automatically from the stored value. With an Octopus card, you no longer need coins.

MTR Customer Service Centres:	All station (expect Racecourse station)
Light Rail Customer Service Centres:	Ferry Pier Terminus, Leung King, Town Centre, Yuen Long Terminus, Tin Yat, Siu Hong and Tin Shui Wai stations
KMB Customer Service Centres:	Sha Tin Central Bus Terminus
New World First Ferry Customer Service Centres:	Piers of Cheung Chau, Mui Wo, Peng Chau, Central Piers 5 &6
New World First Bus Customer Service Centres:	Admiralty (East) Bus Terminus

Transportation
Hong Kong is geographically compact and boasts one of the world's most efficient, safe, affordable and frequent public transport systems. Whether by taxi, ferry, rail, bus or tram, you can get around easily and catch wonderful glimpses of the city along the way.

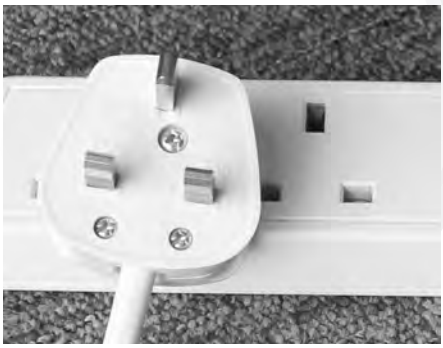
For convenience, use the Octopus Card, an electronic stored-value card that is accepted on most public transport.

Tax and Tipping
Hong Kong is free of sales tax. The only tax you may be charged is 5% government tax on hotel rates. Most upscale hotels add this to a 10% service charge, making for a total surcharge of 15%. Tipping is optional. Some restaurants have 10% service charge.

Telephone
Country Code: 852
City Code: not required
Emergency: 999

Time Zone
GMT/UTC +8 (no daylight savings time)

Power Supply
220-Volt / 50-Hz system



Smoking
Smoking is forbidden by law in public transportation and in all closed public areas.

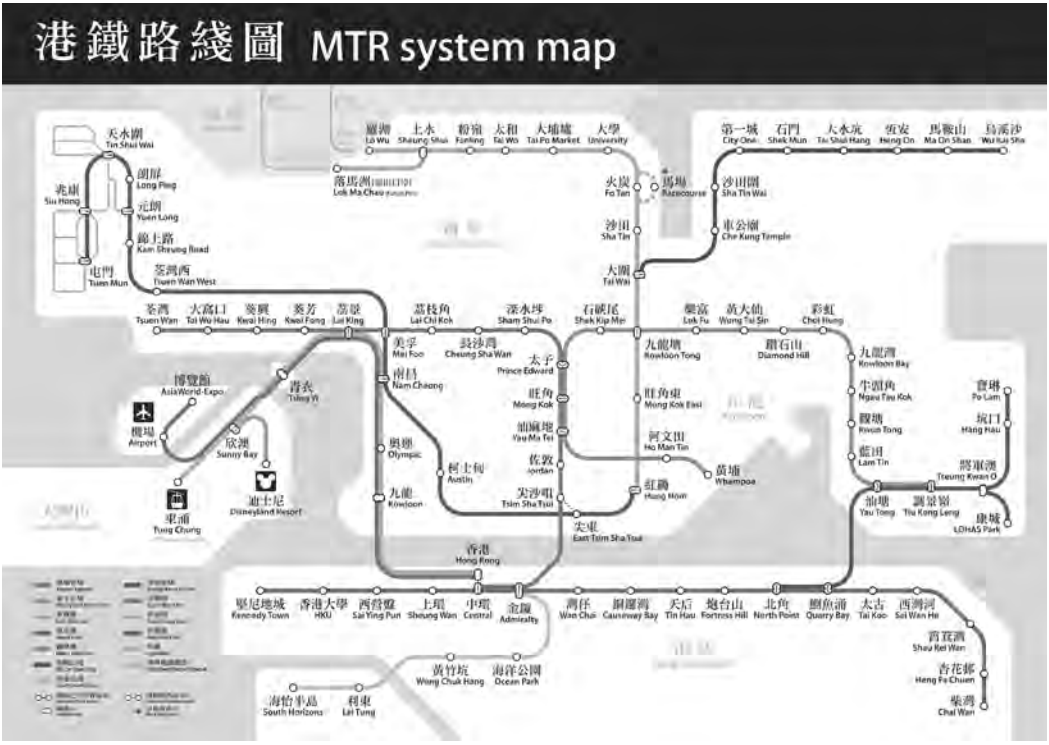
Travel and about Hong Kong
Hong Kong is a charming city and she is frequently described as a place where "East meets West", reflecting the culture's mix of the territory's Chinese roots with influences from its time as a British colony. Hong Kong balances a modernised way of life with traditional Chinese practices. The fusion of east and west also characterises Hong Kong's cuisine, where dim sum, hot pot, and fast food restaurants coexist with haute cuisine. She is also famous of the beautiful victory harbour view and over several thousands of skyscrapers.

Hong Kong has many kinds of theme parks. The most famous one should be the Hong Kong Disneyland. Some theme parks are for educational purpose, including the Hong Kong Ocean Park, the Hong Kong Wetland Park and Noah's Art.

Shopping
Most shops open 10:00 to 22:00, Monday to Sunday.

Shopping districts: Mong Kok, Causeway Bay, Wan Chai, and Tsim Sha Tsui and Sham Shui Po.

Shopping Malls: IFC Mall, Times Square, ELEMENTS, Harbour City, Festival Walk, APM, Sogo, Wing On and Citygate Outlets.



Walking Route to Symposium Venue

Li Dak Sum Yip Yio Chin Academic Building
Tat Chee Avenue, Kowloon, Hong Kong SAR

How to get to Li Dak Sum Yip Yio Chin Academic Building

Arrived at Pedestrian Subway

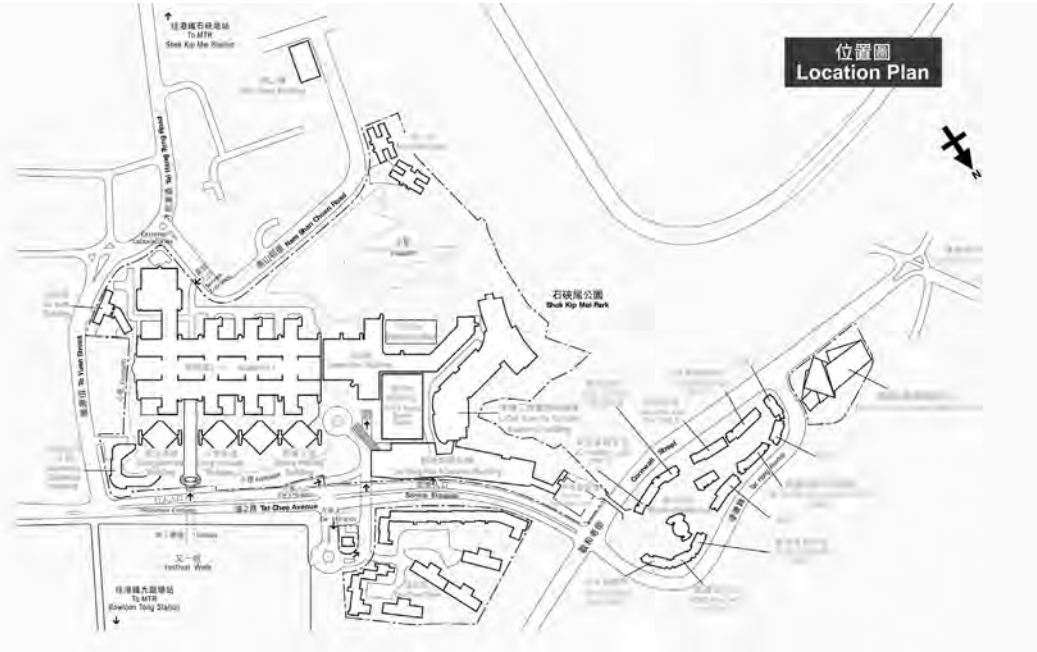
When you get off the MTR, look for Festival Walk exit.
In Festival Walk, on Level LG1, there is a Pedestrian Subway which will lead you to CityU campus.

After walking through the Pedestrian Subway, go down the staircase on your right and follow the directional signs, you will find yourself walking under a covered corridor alongside the garden which will lead you to the University Circle.

Go along the covered walkway and follow the directional signs which will lead you to Li Dak Sum Yip Yio Chin Academic Building.

Arrived at University Circle

When you drop off at the University Circle, go along the covered walkway and follow the directional signs which will lead you to Li Dak Sum Yip Yio Chin Academic Building.



Symposium Information

Registration

Date	Opening Hours	Venue
24 May 2017 (Wednesday)	0830-1600	Room 2513, 2/F, Li Dak Sum Yip Yio Chin, Academic Building, City University of Hong Kong
25 May 2017 (Thursday)	0830-1530	
26 May 2017 (Friday)	0830-1100	
Payment	- Cash (HKD) - Credit card (Visa, Master or UnionPay)	

All participants could make registration and collect program package or any additional purchase at the registration desk as per the information provided as above. Printed receipts will be provided once payment is received.

Keynote Speeches

Date	24 May 2017 (Wednesday)
Time	0915 – 1230
Venue	Room 3505, 3/F, Li Dak Sum Yip Yio Chin Academic Building, City University of Hong Kong

Invited and Regular Sessions

Date	24 – 26 May 2017 (Wednesday to Friday)
Time	1400 – 1800 (24 May, Wednesday) 0850 – 1230, 1520 – 1700 (25 May, Thursday) 0850 – 1230 (26 May, Friday)
Venue	Room 2505, 2510, 2/F, Li Dak Sum Yip Yio Chin Academic Building, City University of Hong Kong

Poster Sessions

Date	25 May 2017 (Thursday)
Time	1400 – 1500
Venue	Room 2421, 2419, 2/F, Li Dak Sum Yip Yio Chin Academic Building, City University of Hong Kong

Presentation Instruction

Oral Sessions

Speakers are required to download and test their presentation files in a computer provided at the conference venue. An authorized assistant will copy the files to the computer. Please save your files in a USB memory stick in MS-Power Point or Adobe PDF format and arrive the venue at least 15 minutes in advance before your session starts.

As reminder that all speakers cannot use their personal computers for presentation.

Please make sure the files are compatible to Windows software (XP / Vista / 7) and check for the appropriate video codecs, before starting your session.

Poster Sessions

Posters must be displayed in portrait format, A0 in size (width = 84 cm x height = 120 cm; width = 33.11 inch x height = 46.81 inch). Each poster board is marked with the paper ID-number.

Posters should be on the board 15 minutes before presentation. Authors are required to stand by their posters during the whole poster session, and to remove them from the boards immediately after the end of the poster session.

Conference Lunches and Welcoming Reception

3 day lunches (12:30 – 14:00 on 24 – 26 May), a welcoming reception (24 May night) will be held on 8/F, Lau Ming Wai Academic Building, City University of Hong Kong, which has excellent view of Kowloon and Hong Kong Island. During the lunches and a welcoming reception, western meal will be served to all participants.

Banquet

25 May 2017 (Thursday)
1830~2200
Grand Ballroom III, Level 6 (六樓 喜宴堂 III), Royal Plaza Hotel
193 Prince Edward Road West, Kowloon

Keynote Speech 1

Progress in THz Technology Enabled by Photonics

by

Cyril Renaud

Reader in Photonics, Site Director, Centre for Doctoral Training: Integrated Photonic and Electronic Systems, UCL Electronic and Electrical Eng./ Photonics Group

Abstract

As THz and millimetre wave technologies are further developing for a range of applications, photonics is one of the key technology for its development. We will discuss the different recent advances in photonic technologies for THz and millimetre wave. In particular we will look at integration technologies and their potential for reduced foot print and lower power consumption. We will although look at the comparative progress of electronic based solutions and discuss the future outlook of both technologies.

Biography

Cyril Renaud received the degree of engineering from the Ecole Supérieure d'Optique, Orsay, France, and the Diplôme d'Etudes Approfondies (D.E.A.) in Optics and Photonics from the University Paris XI, Orsay, France, in 1996. He spent one year as a project engineer with Sfim-ODS, working on the development of microchips lasers and portable range finders. He, then, joined the Optoelectronics Research Centre, University of Southampton, Southampton UK, in 1998, to work on diode pumped high-power ytterbium-doped fibre-lasers, with particular interest on Q-switched system and 980-nm generation. This work led to the award of a PhD in 2001. He is currently a Reader in Photonics at University College London, and the UCL site director for the UCL/Cambridge Doctoral Training Centre in Integrated Photonic and Electronic Systems. His work has led to over 130 publications in peer reviewed journals and international conferences, attracting over 1400 citations, and 3 patents.

Keynote Speech 2

Terahertz Electronics and Performance Enhancement towards the Post-Moore Era

by

Hideyuki Nosaka

NTT Device Technology Laboratories, NTT Corporation

Abstract

Millimeter-wave and terahertz bands are expected to be used for ultra-high-speed wireless and optical transmission, sensing, imaging, and other high frequency applications because of their light-like broad band and penetration ability. This talk introduces 300-GHz-band wireless communication ICs in InP HEMT technology and over 100-Gbit/s optical communication ICs in InP HBT technology. The talk will conclude with a presentation of a new performance enhancement approach combining silicon CMOS LSIs and high-speed compound semiconductor ICs for the post-Moore era.

Biography

Hideyuki Nosaka received the B.S. and M.S. degrees in physics from Keio University, Yokohama, Japan, in 1993 and 1995, respectively, and the Dr. Eng. degree in electronics and electrical engineering from the Tokyo Institute of Technology, Tokyo, Japan, in 2003.

In 1995, he joined NTT Wireless System Laboratories, Kanagawa, Japan, where he was engaged in research and development of direct digital frequency synthesizers (DDFS). Since 1999, he has been engaged in research and development of mixed-signal ICs for 10-to-400-Gb/s optical communications systems at NTT Photonics Laboratories, Kanagawa Japan. He is currently a senior research engineer, supervisor, and group leader of the High-Speed Analog Circuit Research Group at NTT Device Technology Laboratories, Kanagawa, Japan.

Dr. Nosaka is a member of the IEEE Microwave Theory and Techniques Society (MTT-S), the IEEE Solid-State Circuits Society (SSCS), and the Institute of Electronics, Information and Communication Engineers (IEICE) of Japan. He served as chair of the High-speed Digital, Mixed Signal, and Optoelectronics ICs subcommittee of the IEEE Compound Semiconductor Integrated Circuits Symposium (CSICS). He is also a member of the IEEE MTT-S Technical Committee Digital Signal Processing (MTT-9) and the International Technical Program Committee of the IEEE International Solid-State Circuits Conference (ISSCC).

Keynote Speech 3

Plasmonic Terahertz Optoelectronics for Advanced Terahertz Imaging and Sensing

by

Mona Jarrahi

Associate Professor of Electrical Engineering, University of California Los Angeles

Abstract

In the first part of this talk, I will give an overview of the unique applications of terahertz waves for chemical identification, material characterization, biomedical sensing and diagnostics and describe the state of the existing terahertz sensors. In the second part of the talk, I will introduce a game changing technology that enables high performance, low cost, and compact terahertz spectroscopy and imaging systems for various applications. More specifically, I will introduce a new generation of optically driven terahertz sources and detectors that offer three orders of magnitude higher terahertz radiation power levels and two orders of magnitude higher terahertz detection sensitivity levels compared to the existing technologies. This leap-frog performance enhancement is achieved by funneling the laser light through specifically engineered metallic nanostructures into the device active area, enhancing light matter interaction at nanoscale. Moreover, this technology is optimized for operation at near infrared optical wavelengths, where very high performance, compact and cost-effective optical sources are commercially available, paving the way to compact and low-cost terahertz sensors that could offer numerous opportunities for e.g., medical imaging and diagnostics, atmospheric sensing, pharmaceutical quality control, and security screening systems.

Biography

Mona Jarrahi received her B.S. degree in Electrical Engineering from Sharif University of Technology in 2000 and her M.S. and Ph.D. degrees in Electrical Engineering from Stanford University in 2003 and 2007. She served as a Postdoctoral Scholar at University of California Berkeley from 2007 to 2008. After serving as an Assistant Professor at University of Michigan Ann Arbor, she joined University of California Los Angeles in 2013 as an Associate Professor of Electrical Engineering and the Director of the Terahertz Electronics Laboratory.

Prof. Jarrahi has made significant contributions to the development of ultrafast electronic and optoelectronic devices and integrated systems for terahertz and millimeter-wave sensing, imaging, computing, and communication systems by utilizing novel materials, nanostructures, and quantum well structures as well as innovative plasmonic and optical concepts. The outcomes of her research has appeared in more than 150 publications and 120 keynote/plenary/invited talks and have received a significant amount of attention from scientific news outlets including Huffington Post, Popular Mechanics, EE Times, IEEE Spectrum, Optics & Photonics News Magazine, Laser Focus world, and Photonics Spectra Magazine. Her scientific achievements have been recognized by several international and national prestigious awards including the Presidential Early Career Award for Scientists and Engineers (PECASE); Friedrich Wilhelm Bessel Research Award from Alexander von Humboldt Foundation; Moore Inventor Fellowship from the Gordon and Betty Moore Foundation; Kavli Fellowship by the USA National Academy of Sciences (NAS), Grainger Foundation Frontiers of Engineering Award from the USA National Academy of Engineering (NAE); Breakthrough Award from Popular Mechanics Magazine; Early Career Award in Nanotechnology from the IEEE Nanotechnology Council; Outstanding Young Engineer Award from the IEEE Microwave Theory and Techniques Society; Booker Fellowship from the USA National Committee of the International Union of Radio Science; Lot Shafai Mid-Career Distinguished Achievement Award from the IEEE Antennas and Propagation Society; Early Career Award from the USA National Science Foundation (NSF); Young Investigator Awards from the USA Office of Naval Research (ONR), the Army Research Office (ARO), and the Defense Advanced Research Projects Agency (DARPA); the Elizabeth C. Crosby Research Award from the University of Michigan; Distinguished Alumni Award from Sharif University of Technology; and best-paper awards at the International Microwave Symposium, International Symposium on Antennas and Propagation, and International Conference on Infrared, Millimeter, and Terahertz Waves. Prof. Jarrahi is a senior member of IEEE, OSA, and SPIE societies, a Distinguished Lecturer of IEEE Microwave Theory and Techniques Society, a Traveling Lecturer of OSA, and a Visiting Lecturer of SPIE.

Best Paper and Student Paper Competition

All papers are automatically eligible for the prizes, and have been appreciated by the TPC and review board. The short lists of best paper and best student paper have been defined and the nominated student authors will be contacted to confirm their acceptance to participate in the student paper competition.

The best paper and student paper finalists will present their posters at a session running parallel on 25 May for evaluation by a Jury. Papers will be judged on originality, clarity, potential impact on practical applications or theoretical foundations and quality of presentation.

The best paper and student paper awards will be presented at THE BANQUET ON 25 MAY.

Short list of BEST PAPERS

Phase Locked Loop with Spur Reduction Using Frequency Expansion Technique
Wen-Cheng Lai, Sheng-Lyang Jang, Kei-Wu Lu, and Yen-Jung Su
National Taiwan University of Science and Technology, Taiwan

Multiport Microstrip Grid Array Antenna
Yueping Zhang
Nanyang Technological University, Singapore

Compact dual-frequency antenna for 2.4/60 GHz applications
Yu-Xiang Sun[1], Kwok Wa Leung[1], and Jun-Fa Mao[2]
[1]City University of Hong Kong, Hong Kong SAR
[2]Shanghai Jiao Tong University, China

Design of an Ultra-wideband and Highly-directive Photoconductive THz Vivaldi Antenna
Amira Dhiflaoui[1], Hatem Rmili[1,2], Oussema Boularess[1], Ali Yahyaoui[1,3], Taoufik Aguili[1], and Raj Mittra[2,4]
[1]University of Tunis El Manar, Tunisia
[2]King Abdulaziz University, Saudi Arabia
[3]University of Jeddah, Saudi Arabia
[4]University of Central Florida, United States

Millimeter Wave Antenna Array Based on Dielectric-Filled Waveguides
Juha Ala-Laurinaho, Vasilii Semkin, Henri Kähkönen, Ville Viikari, and Antti Räisänen
Aalto University, Finland

Double-Polarization Frequency Selective Rasorber Based on Cross-Frame and Circle Ring Slot Arrays
Xin Xiu, Ye Han, Wenquan Che, and Wanchen Yang
Nanjing University of Science and Technology, China

Tunable Perfect Absorber for Bio-sensing
Luigi Bibbò, Qiang Liu, Mi Lin, Qiong Wang, and Zhengbiao Ouyang
Shenzhen University, China

Compact, Omni-Directional, Circularly-Polarized mm-Wave Antenna for Device-to-Device (D2D) Communications in Future 5G Cellular Systems
Wei Lin and Richard W. Ziolkowski
University of Technology Sydney, Australia

Short list of BEST STUDENT PAPERS

Development of a 0.85 THz Nb-AlN-NbN Superconductor-Insulator-Superconductor Mixer
Ming Yao[1,2,3], Jing Li[1,2], Dong Liu[1,2,3], Shaoliang Li[1,2,3], Shengcai Shi[1,2], Pavel Dmitriev[4], Michael Fominsky[4], and Valery Koshlets[4]
[1]Purple Mountain Observatory, Chinese Academy of Sciences, China
[2]Key Laboratory of Radio Astronomy, Chinese Academy of Sciences, China
[3]University of Chinese Academy of Sciences, China
[4]Kotel'nikov Institute of Radio Engineering and Electronics, Russian Academy of Sciences, Russia

Experimental Characterization of Terajet Generated from Dielectric Cuboid under Different Illumination Conditions
Hai Huy Nguyen Pham[1], Shintaro Hisatake[1], Tadao Nagatsuma[1], Igor Vladilenovich Minin[2], and Oleg Vladilenovich Minin[3]
[1]Osaka University, Japan
[2]National Research Tomsk Polytechnic University, Russia
[3]National Research Tomsk State University, Russia

A Millimeter-Wave Sequential Power Amplifier
Guansheng Lv, Wenhua Chen, and Zhenghe Feng
Tsinghua University, China

Focused Array Antenna with 2-D Steerable Focus
Peng-Fa Li, Shi-Wei Qu, Yuan-Song Zeng, and Shiwen Yang
University of Electronic Science and Technology of China, China

IR-Fresnel Zone Plate Lens acting as THz Antenna
Alicia Elena Torres-García, Bakhtiyar Orazbayev, Iñigo Ederra, and Ramón Gonzalo
Universidad Pública de Navarra, Spain

Wide-Angle Beam Scanning Reflectarray Antenna Design Using Phase Matching Method
Geng-Bo Wu[1], Shi-Wei Qu[1], and Chi Hou Chan[2]
[1]University of Electronic Science and Technology of China, China
[2]State Key Lab of Millimeter Waves, Partner Laboratory in City University of Hong Kong, Hong Kong SAR

Low-Profile Dipole Array Fed Transmitarray
Peng-Yu Feng, Shi-Wei Qu, and Shiwen Yang
University of Electronic Science and Technology of China, China

Subreflectarrays for Ring-Focus Reflector Antenna
Chao Ma, Shi-Wei Qu, and Shiwen Yang
University of Electronic Science and Technology of China, China

Technical Program

24 May, 2017 (Wednesday)

0830-1600

Registration

Room 2513, 2/F, Li Dak Sum Yip Yio Chin, Academic Building, CityU

0900-0915

Opening Ceremony

Room 3505, 3/F, Li Dak Sum Yip Yio Chin Academic Building, CityU

0915-1015

Keynote Speech 1

Progress in THz Technology Enabled by Photonics
Cyril Renaud

1015-1030

Tea Break

1030-1130

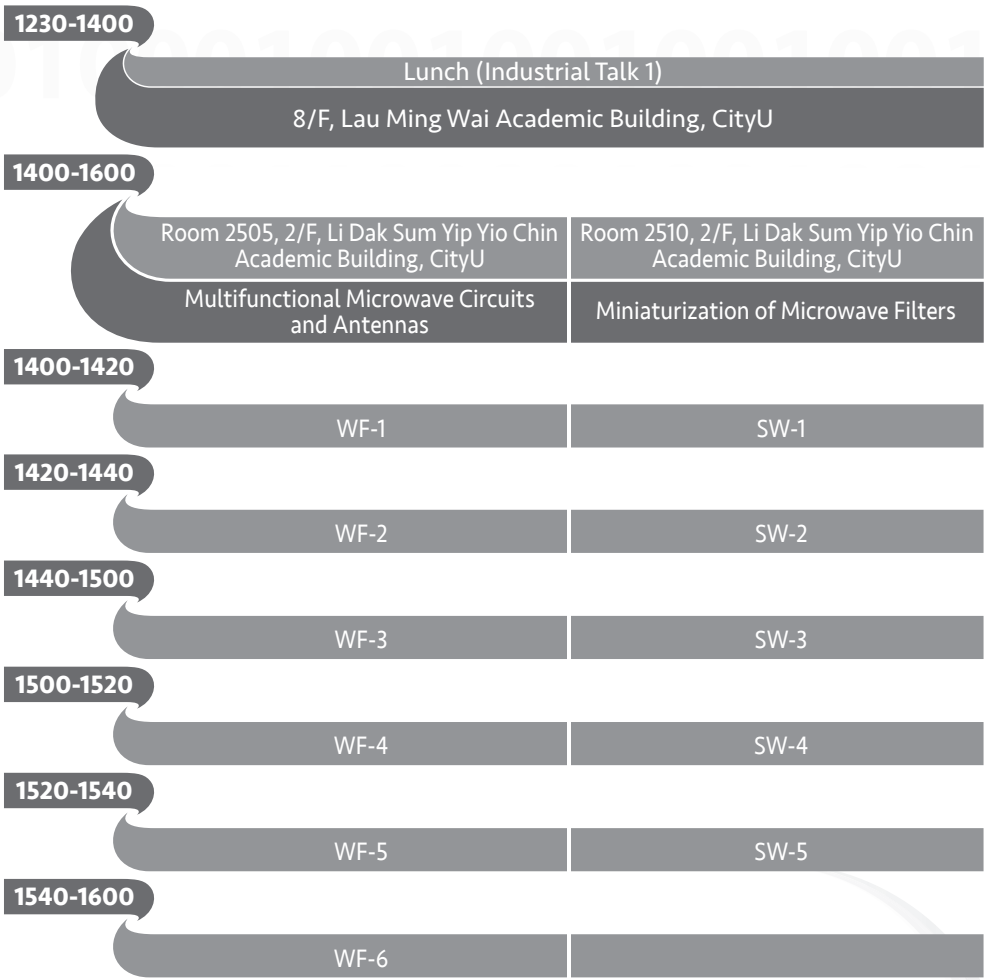
Keynote Speech 2

Terahertz Electronics and Performance Enhancement towards the Post-Moore Era
Hideyuki Nosaka

1130-1230

Keynote Speech 3

Plasmonic Terahertz Optoelectronics for Advanced Terahertz Imaging and Sensing
Mona Jarrahi


1230-1400
Lunch (Industrial Talk 1)
8/F, Lau Ming Wai Academic Building, CityU
1400-1600
Room 2505, 2/F, Li Dak Sum Yip Yio Chin Academic Building, CityU
Multifunctional Microwave Circuits and Antennas
Room 2510, 2/F, Li Dak Sum Yip Yio Chin Academic Building, CityU
Miniaturization of Microwave Filters
1400-1420
WF-1
SW-1
1420-1440
WF-2
SW-2
1440-1500
WF-3
SW-3
1500-1520
WF-4
SW-4
1520-1540
WF-5
SW-5
1540-1600
WF-6

1600-1620

Tea Break

1620-1800

Room 2505, 2/F, Li Dak Sum Yip Yio Chin Academic Building, CityU
Millimeter-Wave Antennas and Passive Devices

1620-1640

MA-1

1640-1700

MA-2

1700-1720

MA-3

1720-1740

MA-4

1740-1800

MA-5

1800-2000

Welcoming Reception

8/F, Lau Ming Wai Academic Building, CityU

25 May, 2017 (Thursday)

0830-1530 Registration

Room 2513, 2/F, Li Dak Sum Yip Yio Chin, Academic Building, CityU

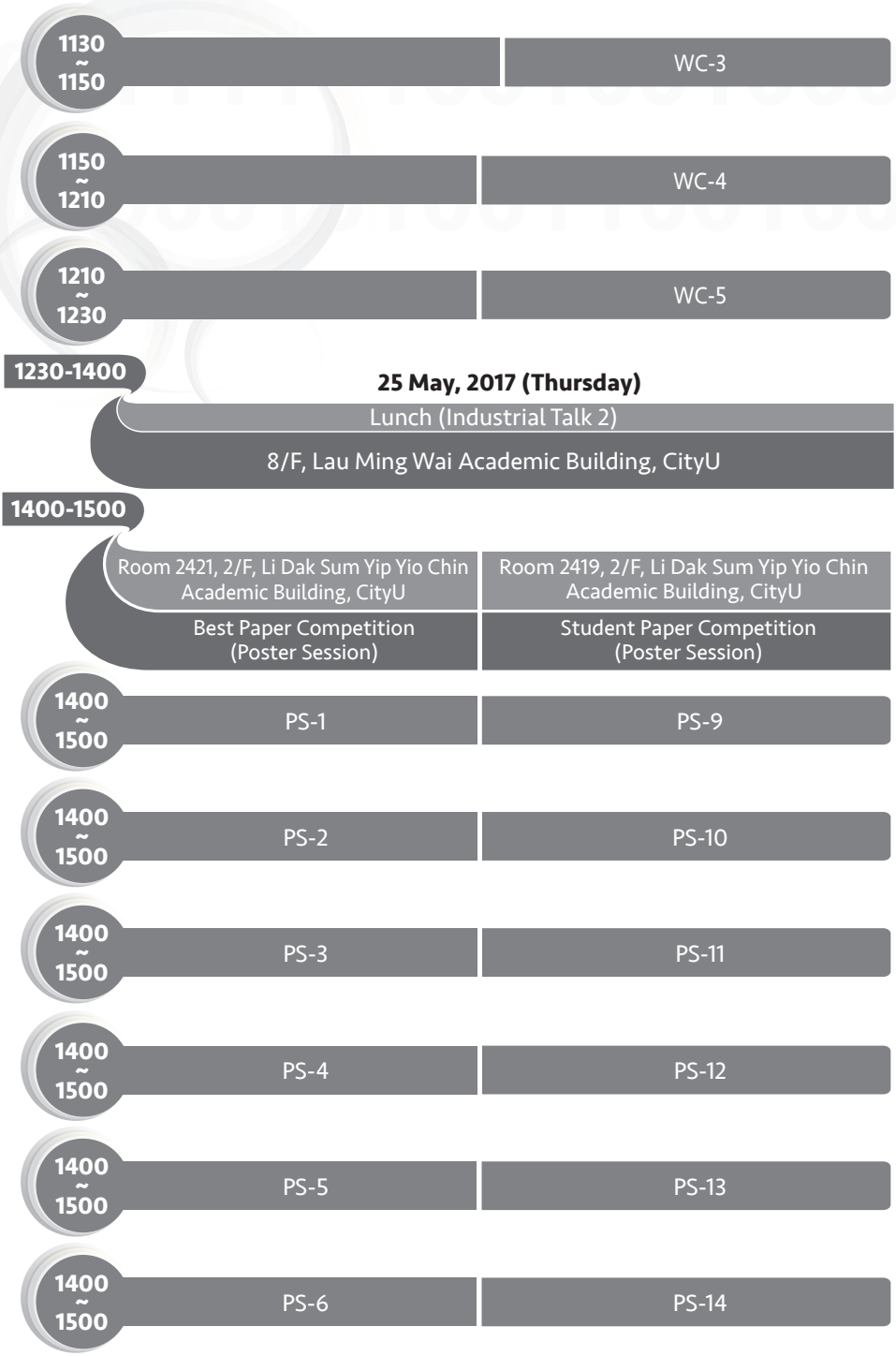
0850-1030

	Room 2505, 2/F, Li Dak Sum Yip Yio Chin Academic Building, CityU	Room 2510, 2/F, Li Dak Sum Yip Yio Chin Academic Building, CityU
	Microwave and Millimeter Wave Application	Antennas and Computational Methods for Millimeter-Wave Applications
0850 ~ 0910	HL-1	YL-1
0910 ~ 0930	HL-2	YL-2
0930 ~ 0950	HL-3	YL-3
0950 ~ 1010	HL-4	YL-4
1010 ~ 1030	HL-5	YL-5

1030-1050 Tea Break

1050-1230

	Room 2505, 2/F, Li Dak Sum Yip Yio Chin Academic Building, CityU Microwave and Millimeter Wave Application	Room 2510, 2/F, Li Dak Sum Yip Yio Chin Academic Building, CityU Millimeter Wave Power Amplifier for 5G
1050 ~ 1110	HL-6	WC-1
1110 ~ 1130	HL-7	WC-2


1130 ~ 1150
WC-3
1150 ~ 1210
WC-4
1210 ~ 1230
WC-5
1230-1400
25 May, 2017 (Thursday)
Lunch (Industrial Talk 2)
8/F, Lau Ming Wai Academic Building, CityU
1400-1500
Room 2421, 2/F, Li Dak Sum Yip Yio Chin Academic Building, CityU
Room 2419, 2/F, Li Dak Sum Yip Yio Chin Academic Building, CityU
Best Paper Competition (Poster Session)
Student Paper Competition (Poster Session)
1400 ~ 1500
PS-1
PS-9
1400 ~ 1500
PS-2
PS-10
1400 ~ 1500
PS-3
PS-11
1400 ~ 1500
PS-4
PS-12
1400 ~ 1500
PS-5
PS-13
1400 ~ 1500
PS-6
PS-14

1400 ~ 1500	PS-7	PS-15
1400 ~ 1500	PS-8	PS-16

1500-1520 **25 May, 2017 (Thursday)**

Tea Break

1520-1700

Room 2505, 2/F, Li Dak Sum Yip Yio Chin Academic Building, CityU
Millimeter-Wave and THz Communications & Millimeter-Wave Active Devices and ICs

1520 ~ 1540	MB-1
1540 ~ 1600	MB-2
1600 ~ 1620	MB-3
1620 ~ 1640	MB-4
1640 ~ 1700	MB-5

1830-2200

Banquet
Grand Ballroom III, Level 6 (六樓 喜宴堂 III), Royal Plaza Hotel,
193 Prince Edward Road West, Kowloon

26 May, 2017 (Friday)

0830-1100 Registration

Room 2513, 2/F, Li Dak Sum Yip Yio Chin, Academic Building, CityU

0850-1030

	Room 2505, 2/F, Li Dak Sum Yip Yio Chin Academic Building, CityU	Room 2510, 2/F, Li Dak Sum Yip Yio Chin Academic Building, CityU
	Wireless Power Transmission and RF Energy Harvesting	Millimeter-Wave and THz Sensing, Sub-millimeter-wave and THz Technologies & Millimeter-Wave Antennas and Passive Devices
0850 ~ 0910	HS-1	MC-1
0910 ~ 0930	HS-2	MC-2
0930 ~ 0950	HS-3	MC-3
0950 ~ 1010	HS-4	MC-4
1010 ~ 1030	HS-5	MC-5

26 May, 2017 (Friday)

1030-1050 Tea Break

1050-1230

Room 2505, 2/F, Li Dak Sum Yip Yio Chin Academic Building, CityU
Novel Microwave and Millimeter-Wave Substrate Integrated Antenna and Array Technology

1050 ~ 1110

1110 ~ 1130 YC-2

1130 ~ 1150 YC-3

1150 ~ 1210 YC-4

1210 ~ 1230 YC-5

1200-1400 Lunch

8/F, Lau Ming Wai Academic Building, CityU

24 May, 2017 (Wednesday)

Room 3505, 3/F, Li Dak Sum Yip Yio Chin
Academic Building, CityU

0900 ~ 0915 Opening Ceremony

0915 ~ 1015 Keynote Speech 1

Session Chair: Hang Wong

Progress in THz Technology Enabled by Photonics

Cyril Renaud

Reader in Photonics, Site Director, Centre for Doctoral Training: Integrated Photonic and Electronic Systems, UCL Electronic and Electrical Eng./ Photonics Group

1015 ~ 1030 Tea Break

1030 ~ 1130 Keynote Speech 2

Session Chair: Hang Wong

Terahertz Electronics and Performance Enhancement towards the Post-Moore Era

Hideyuki Nosaka

NTT Device Technology Laboratories, NTT Corporation

1130 ~ 1230

Keynote Speech 3

Session Chair: Hang Wong

Plasmonic Terahertz Optoelectronics for Advanced Terahertz Imaging and Sensing

Mona Jarrahi

Associate Professor of Electrical Engineering, University of California Los Angeles

1230 ~ 1400

Lunch (Industrial Talk 1)

Room: 2505, 2/F, Li Dak Sum Yip Yio Chin Academic Building, CityU

Multifunctional Microwave Circuits and Antennas

Session Chairs: Wenjie Feng and Yongle Wu

Room: 2510, 2/F, Li Dak Sum Yip Yio Chin Academic Building, CityU

Miniaturization of Microwave Filters

Session Chairs: Sai-Wai Wong and Qingfeng Zhang

1400 ~ 1420

WF-1

A Dual-Band Coupled-Line Bandpass Filter and the Prediction of Its Transmission Poles and Zeros

Yongle Wu, Lingxiao Jiao, and Yuanan Liu
Beijing University of Posts and Telecommunications, China

This paper presents a dual-band coupled-line band-pass filter, which is simply composed by a three-section coupled line and two short-circuited stubs. By rigorous derivation, its transmission zeros and poles are extracted, and thus can be predicted. Finally, the simulations and experiments are carried out, and the results match well with the predicted ones.

SW-1

A Tunable Bandpass-to-Bandstop Filter Using Stub-Loaded Resonators and PIN Diode

Run-Shuo Li, Fu-Chang Chen, and Qiang Shao
South China University of Technology, China

A tunable bandpass-to-bandstop filter using stubloaded resonators is proposed in this letter. The proposed filter employs two open-circuited stub-loaded resonators with six varactors and a PIN diode. The center frequency of the proposed filter can be flexibly controlled by adjusting both odd-mode and even-mode resonant frequencies of the resonators. The bandpass-to-bandstop transformation can be achieved by adjusting the PIN diode. In the bandpass mode, a tuning range of 680-985 MHz (36.6%) with return loss better than 13.5 dB can be achieved. In the bandstop mode, a tuning range of 715-995 MHz (32.7%) can be achieved. The rejection level of the bandstop mode is higher than 13 dB.

WF-2

Balanced/Balun Filters Based on Dielectric Resonators

Wei Qin and Jian-Xin Chen
Nantong University, China

Dielectric resonator (DR) owns advantages of high quality factor, high power capacity, superior temperature stability, moderate circuit size, etc., emerging as a promising candidate for future small base station systems. According to the field distribution of the DR's fundamental mode, proper excitation schemes are established to differentially feed the DR so that it can be applied in designing balanced/Balun filters. The most used DRs in microwave filter designs are rectangular and circular ones, as well as their derivations. This paper gives a review of the recent works on balanced/Balun filters based on the various types of dielectric resonators (DRs), which have been pursued by the authors' research group.

SW-2

On-Chip Circuit Miniaturization Techniques for Millimeter-Wave Bandpass Filter Design

Yang Yang[1,3], Xi Zhu[1], and Quan Xue[2,3]
[1]University of Technology Sydney, Australia
[2]State Key Laboratory of Millimeter Waves, City University of Hong Kong, Hong Kong SAR
[3]Shenzhen Research Institute, City University of Hong Kong, China

In this paper, the millimeter-wave circuit miniaturization techniques using BCMLR and interdigital resonators are introduced. Using these structures, the physical size of the on-chip filter can be dramatically reduced. The designed BPFs are implemented in standard 0.13-µm SiGe and 0.1-µm GaAs technologies for concept approval. Compared with other state-of-the-art work at millimeter-wave frequencies, our proposed designs have the merits of ultra-compact size as small as 0.038 mm2, competitive insertion loss (1 dB in GaAs BPF) and harmonic suppression of more than 44 dB.

1440 ~ 1500

WF-3

Multi-functional Antennas using Polarization-Rotation Artificial Magnetic Conductor Structures

Wanchen Yang, Dongxu Chen, Wenquan Che, and Wenjie Feng
Nanjing University of Science and Technology, China

A novel polarization rotation technique based on an artificial magnetic conductor (AMC) structure is proposed. A new polarization-rotation AMC (PRAMC) with a height of only 0.04 λ_0 is designed and a large polarization rotation bandwidth of 29.1% can be achieved. Firstly, the PRAMC is applied to design a low-profile circularly polarized dipole antenna with a broad axial ratio bandwidth and beamwidth. In addition, combining a PRAMC-based multi-polarized dipole antenna with a switch network, a novel polarization-reconfigurable antenna is achieved, in which three polarization states of right-handed, left-handed circular polarization (RHCP, LHCP) and +45° linear polarization (LP) can be realized by controlling the dc bias of the switches accordingly. Moreover, a new active corner-cut PRAMC loading with several varactors is proposed to achieve a novel frequency- and polarization-reconfigurable dipole antenna for applications in multi-function wireless communication systems.

SW-3

A Compact Dual-Mode Bandpass Filter for GPS, Compass (Beidou) and GLONASS

Shan Shan Gao[1,2], Hui Lai Liu[3], Jia Lin Li[1], and Wei Wu[2]
[1]University of Electronic Science and Technology of China, China
[2]Chengdu University, China
[3]Canaanteck Pte. Ltd, China

A dual-mode bandpass filter with compact size is proposed by using a new type of rotational symmetric dual-mode rectangular resonator. Due to the feed structure, two transmission zeros are generated near the lower and upper passbands to improve the skirt-selectivity of the filter. By adjusting the mutual coupling between the loading meander-line loop resonators, one transmission pole and neighboring transmission zero can be controlled. Two capacitors are added between each meander-line loop resonator and feedline to improve in-band performance. Based on this topology, a compact filter for GPS/Compass (BeiDou)/GLONASS applications has been designed, analyzed and fabricated. Measured results verified the validity of this design methodology. This proposed filter exhibits the small size of 0.11 λg×0.10 λg.

1500 ~ 1520

WF-4

Balanced-to-Unbalanced Filtering Power Divider Using Ring Resonators

Wenjie Feng, Rui Yin, and Wenquan Che
Nanjing University of Science and Technology, China

A novel balanced-to-unbalanced filtering power divider using ring resonators is proposed. Due to the symmetry of the circuit model, even/odd-mode analysis method is applied to deduce the design equations at the operating frequency. The ring resonators can bring two transmission zeros in each side of the passband for differential-mode, which can improve frequency selectivity and out-of-band suppression. A fabricated prototype (ε_r = 2.65, h = 1 mm, tan δ = 0.003) with 4-dB bandwidth of 12.5% is designed and measured to prove the proposed methods.

SW-4

Tri-Mode Stub-Loaded Ring Resonator And Its Application to Miniaturized Wideband Bandpass Filter Design

Xiaohu Wu, Hucheng Sun, and Junxiang Ge
Nanjing University of Information Science and Technology, China

Stub-loaded ring resonator and its application to miniaturized wideband BPF are presented in the paper. Detail analysis shows that the presented stub-loaded ring resonator can allocate three resonant modes within the desired frequency range, and due to the dual path effect of the ring resonator, two transmission zeros can be introduced at the upper and lower cutoff frequencies, resulting high passband selectivity. A tri-mode wideband BPF is simulated, fabricated, and measured. The EM simulated and measured results are presented, and an excellent agreement is obtained.

1520 ~ 1540

WF-5

Filtering Balanced/Balanced-to-single-ended Networks

Jin Shi, Kai Xu, Jianpeng Lu, and Jun Qiang
Nantong University, China

Balanced/balanced-to-single-ended networks have been used widely in modern communication systems due to their ability of easy connection in balanced systems as well as differential-mode power division, common-mode suppression. Furthermore, filtering balanced or balanced-to-single-ended networks have become increasingly of interest for the advantages of multiple functions and compactness. In this paper, the filtering balanced-to-single-ended power dividers and the balanced branch-line couplers realized by replacing the transmission line structures with filtering structures are reviewed and discussed.

SW-5

Synthesis of Lossy Coupling Matrix for Negative Group Delay Filters

Ranjan Das[1,2], Qingfeng Zhang[1], Abhishek Kandwal[1], and Yifan Chen[1]
[1]Southern University of Science and Technology, China
[2]Indian Institute of Technology Bombay, India

A novel systematic synthesis method for negative group delay(NGD)structure is proposed in this paper. Transfer functions are obtain from synthesised characteristics polynomials which provides higher design flexibility. An optimum design condition is derived to reduce the number of resonators being equal to the highest degree of polynomial. Different synthesis examples are discussed with different orders and NGD responses. The exact agreement between the polynomial and coupling matrix based responses illustrate the proposed synthesis method.

1540 ~ 1600

WF-6

Compact LTCC In-Phase Filtering Power Divider

Xiu Yin Zhang, Wan-Li Zhan, and Xiao-Feng, Liu
South China University of Technology, China

In this paper, a compact in-phase power divider integrated with bandpass responses in low temperature co-fired ceramic (LTCC) technology is presented. The proposed device is composed of three coupled half-wavelength resonators and an isolation resistor. Among them, one resonator acts as the common resonator and is symmetrically coupled to the other two using multiple broadside coupling. In this way, both filtering and power dividing responses are realized. For validation, an inphase filtering power divider centered at 5.45 GHz is designed. The size of the circuit is only $3.3 \times 3.2 \times 1.6$ mm^3.

1600 ~ 1620

Tea Break

Room: 2505, 2/F, Li Dak Sum Yip Yio Chin Academic Building, CityU

Millimeter-Wave Antennas and Passive Devices
Session Chair: Wenquan Che

1620 ~ 1640

MA-1

Tile Type Multi-channel Transceiver Module Applied for Phased Array Antenna

Tai Fuzhou
Southwest China Institute of Electronic Technology, China

In order to reduce the volume and weight of phase array antenna in RF frequency, an integrated technology of multi-channel transceiver circuit and power division network in microwave is proposed for the tile type TR module. The component is integrated in a same dielectric substrate, the mounting interface of chips and power division network are on the same layer. Finally, a 8×8 array has been manufactured and tested to validate its function. The results show the integrated technology has good performance. It is very good to satisfy the miniaturization and lightweight of the T/R module in the active phased array antenna.

1640 ~ 1700

MA-2

A Metallic 3-D Mask Printed D-Band Iris Bandpass Filter

Yong-Xin Guo[1], Bing Zhang[1], Rongqiang Li[1,2]

[1]National University of Singapore, Singapore

[2]Chengdu University of Information Technology, China

This paper presents the design of a D-band (110-170 GHz) iris bandpass filter (BPF) for 3-D printing fabrication. Taking the advantage of the 3-D Mask Printing technology, the dimensional tolerance and surface roughness are much improved compared with the Selective Laser Melting (SLM) printed filter. The 3-D Mask Printed filter has a passband 144-146 GHz ($|S_{11}|$<-18 dB) with in-band insertion loss than 0.6 dB. The measured results will be reported at the conference.

1700 ~ 1720

MA-3

Studies on Applicability of Reverse Offset in Printing Millimeter-Wave Antennas on Flexible Substrates

Jianfang Zheng[1], Juha Ala-Laurinaho[1], Ari Alastalo[2], Tapio Mäkelä[2], Asko Sneck[2], and Antti V. Räisänen[1]

[1]Aalto University, Finland

[2]VTT, Finland

We investigate the applicability of roll-to-roll reverse offset printing for fabrication of millimeter-wave antennas on flexible substrates. The aim is to find a fabrication method for mass production of such antennas; therefore, attention should be paid on such factors as cost, efficiency, and reliable performance of the printed antennas.

1720 ~ 1740

MA-4

Antenna Pair with Self-Interference Cancellation for Full Duplex Communication

Xiyao Wang, Wenquan Che , Wanchen Yang, Wenjie Feng

Nanjing University of Science and Technology, China

A self-interference cancellation (SIC) antenna pair for full duplex communication is proposed. It consists of two aperture-coupled patch antennas with orthogonal linear polarizations and an auxiliary port loaded with a proper reflective termination. The auxiliary port introduces an indirect coupling path and the coupling signal is reflected to RX port and superposed with the direct coupling to make a cancellation. As a result, the isolation between two antennas is improved from 25dB to more than 40dB over the entire working band of 2.35-2.55GHz, while, it has little influence on return losses and radiation patterns of the two antennas. The performances indicate the proposed antenna pair a good candidate for full duplex communication applications.

1740 ~ 1800

MA-5

High Selectivity Wideband Balanced Filter Based on Modified Coupled Lines Structures

Xin Gao, Wenquan Che, and Wenjie Feng
Nanjing University of Science and Technology, China

A novel wideband balanced filter based on modified coupled lines structures is proposed. The presented modified coupled lines structures are implemented by loading open/ shorted stubs at the end of the traditional open coupled lines to perform bandpass and bandstop response. To obtain the high selectivity and good out-of-band suppression for the differential mode, four full-wavelength open stubs are introduced to achieve multiple transmission zeros and further improve the suppression level over a wide frequency band due to the all-stop transmission characteristic for the common mode. A prototype with 3-dB fractional bandwidth of 38% for the differential mode is designed and fabricated for demonstration.

1800 ~ 2000

Welcoming Reception

25 May, 2017 (Thursday)

Room: 2505, 2/F, Li Dak Sum Yip Yio Chin Academic Building, CityU
Microwave and Millimeter Wave Application
Session Chair: Haiwen Liu

Room: 2510, 2/F, Li Dak Sum Yip Yio Chin Academic Building, CityU Academic
Antennas and Computational Methods for Millimeter-Wave Applications
Session Chair: Yujian Li

0850 ~ 0910

HL-1

A Novel FSS Structure with High Selectivity and Excellent Angular Stability for 5G Communication Radome

Tian-Wu Li, Da Li, and Er-Ping Li
Zhejiang University, China

A novel frequency selective surface structure (FSSs) with high selectivity and excellent angular stability is proposed in this paper. To improve the performance of the FSS especially in angular stability, the coupling of capacitive surface and inductive surface is employed to realize the miniaturization of the structural unit around 0.23λ. Furthermore, to enhance the passband of the FSS, a multi-layer FSS structure is adopted to form a 2nd-order filter. In addition, as a bandstop with a high suppression is demanded in the 5G communication, we introduce a "Jerusalem cross" structure in the inductive surface layer ingeniously to add the LC series resonance which can realize a rapid decline in the passband edge. One significant feature of this FSS design is that the passband and stopband can be controlled by different parts of the structure respectively, which greatly improves the FSS stability. Finally, a novel FSS working at the center frequency of 28.5 GHz with a low-profile broadband and a high rejection stopband is designed. It still has a stable transmission performance, when the incident wave angle changes up to 60°. These results demonstrate that the proposed FSS is a good candidate for 5G communication radome.

YL-1

The application of Continuity Condition in Volume-Surface Integral Equation Combined with the Multilevel Fast Multipole Algorithm

Jinbo Liu, Jianxun Su, Hui Zhang and Zengrui Li
Communication University of China, China

The application of the continuity condition of the electric flux field at the conductor-dielectric boundaries is discussed. For the conductor-dielectric composite structures involving closed conducting surfaces, a new form of volume-surface integral equation, combined field integral equation–volume integral equation enforced the continuity condition is proposed. The matrix equation generated by the proposed method can be iteratively solved in a straightforward manner and can benefit from the application of the multilevel fast multipole algorithm. Numerical results show that the explicit enforcement of the continuity condition can reduce not only the peak memory requirement and the CPU time of a single iteration in the solution, but also the total iterative steps to reach convergence.

0910
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0930

HL-2

A Dual-frequency Antenna Based on Substrate Integrated Waveguide (SIW) in Millimeter-Wave Range

Wan Jiang and Changjun Liu
Sichuan University, China

This paper presents a novel way to design dual-frequency slot antenna based on substrate integrated waveguide (SIW) in millimeter wave range. The existing of first two modes in SIW resonator, TE101 and TE102 modes, ensure that slot cuts the current of two modes at the same time which leads to a dual-frequency performance of the slot antenna. The proposed antenna resonates at 25.8 GHz and 31.5 GHz with gain of 6.3 dB and 6.9 dB, respectively.

YL-2

Recent Investigation of Wideband Millimeter-wave Dielectric Reflectarray in Beijing Institute of Technology

Bin Li, Ying Zhou, Meng-Da Wu, Yong Liu, Yu-Ming Wu, and Xin Lv
Beijing Institute of Technology, China

Several wideband millimeter-wave dielectric reflectarray antennas are discussed in this paper. Different phase distributions are realized by changing the shape or material of the array element. Three dielectric reflectarray of 20x20 elements operating at 100GHz are compared. The 1dB gain bandwidths of the dielectric reflectarray are larger than 10% and up to 40%. As compared to the microstrip reflectarray, the dielectric reflectarray can reduce the metal losses and effectively improve the gain bandwidth.

0930
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0950

HL-3

Analysis of Isolation Bandwidth of Miniaturized Wilkinson Power Divider

Hong-Xu Zhu, Pedro Cheong, and Kam-Weng Tam
University of Macau, Macau

In this paper, the resistor effect on isolation bandwidth of a compact Wilkinson power divider is studied. The discussion is based on an equal modified compact power divider on RO4003, with center frequency of 2.4 GHz. In this compact power divider, stepped impedance interdigital coupling sections were introduced to replace the quarter wavelength impedance transformer of Wilkinson power divider to realize the bandpass filtering capability. The theoretical analysis, simulation and measurement results are also discussed in this paper.

YL-3

A Dual-polarized Wideband Substrate-Integrated-Waveguide-Fed Slot Antenna Array for 60 GHz

Zhijiao Chen[1], Xiaohan Wang[1], Limei Qi[1], Xiaoming Liu[1], Yuan Yao[1], Junsheng Yu[1], and Xiaodong Chen[2]
[1]Beijing University of Posts and Telecommunications, China
[2]Queen Mary, University of London, United Kingdom

A dual-polarized wideband substrate-integrated-waveguide fed aperture-coupled slot antenna array for 60 GHz is proposed. By cutting a semicircle shape on the edge of the crossed-slot antenna, the impedance bandwidth of the proposed antenna is effectively widen and achieves overlapped bandwidth of 16.7% for simulated |S11| and |S22|. In addition, over 35 dB isolation between two polarization and low cross-polarization level are achieved for dual-polarization operations. A gain up to 11.4 dB is obtained for 2×2 array. Most importantly, the proposed antenna array uses the aperture coupling method to enable the connection between PCB layers. It could be fabricated by stacking three layers of standard printed circuit board (PCB) laminates. With the advantages of low-cost, convenience of fabrication and desired performances, the proposed antenna is suitable for the millimeter-wave antenna applications.

0950 ~ 1010

HL-4

Pin-loaded Circularly-polarized Patch Antenna with Enhanced Gain

Xiao Zhang and Lei Zhu
University of Macau, Macau

The directivity and gain of a circularly-polarized patch antenna are enhanced by introducing two sets of shorting pins in this paper. The resonant frequency of the antenna is at first studied to demonstrate its increment by making use of the shunt-inductive effect of shorting pins. As a result, its electrical size of a square patch radiator is effectively enlarged so as to enhance its radiation directivity. Next, the two degenerate modes of this resonating patch antenna are properly separated for circularly-polarized radiation by varying the spacing of a pair of shorting pins. In final, the simulated and measured results demonstrate that the directivity of the proposed antenna can be enhanced to 10.8 dBic, with about 2.8 dB increment.

YL-4

A Ka-Band Luneburg Lens Fed by Magneto-Electric Dipole Antenna

Yujian Li and Junhong Wang
Beijing Jiaotong University, China

A Luneburg lens with end-fire magneto-electric (ME) dipole feed is designed in Ka-band for millimeter-wave applications. An impedance bandwidth of wider than 33% for |S11| of less than -10 dB, stable gain of around 19 dBi and symmetrical radiation patterns that are almost identical in two orthogonal planes are achieved by the proposed design.

1010 ~ 1030

HL-5

Development of Superconducting Mixers and Detectors for THz Astronomy

Sheng-Cai Shi[1, 2]
[1]*Purple Mountain Observatory, China*
[2]*Key Lab of Radio Astronomy, CAS, China*

The terahertz (THz) and FIR band is a frequency regime to be fully explored in astronomy. Dome A in Antarctic offers the best possible access for ground-based astronomical observations in this unique frequency regime. In this paper Fourier transform spectrometer (FTS) measurement of THz atmospheric transmission from Dome A is introduced and superconducting mixers and detectors developed for a THz telescope named DATE5 are presented.

YL-5

Wideband Transition between Slotline and SSPP-Based Transmission Line

Di Cao, Yujian Li, and Junhong Wang
Beijing Jiaotong University, China

A wideband transition between the slotline and the spoof surface plasmon polariton (SSPP) based transmission line is proposed for millimeter-wave applications. A compact configuration, wide bandwidth of 61% for |S11| of less than -10 dB, and insertion loss of less than 0.64 dB are obtained.

1030 ~ 1050

Tea Break

Room: 2505, 2/F, Li Dak Sum Yip Yio Chin Academic Building, CityU

Microwave and Millimeter Wave Application

Session Chair: Haiwen Liu

Room: 2510, 2/F, Li Dak Sum Yip Yio Chin Academic Building, CityU

Millimeter Wave Power Amplifier for 5G

Session Chairs: Wenhua Chen and Youjiang Liu

1050 ~ 1110

HL-6

A Multi-band High Selectivity Frequency Selective Surface for Ka-Band Applications

Muaad Hussein, Yi Huang, Bahaa Al-Juboori, and Jiafeng Zhou
University of Liverpool, United Kingdom

This paper proposes a new method to implement Frequency Selective Surfaces (FSSs) with sharp band edge transitions suitable for millimetres wave applications. A bandpass FSS can be realized by combining two bandstop FSS structures on the same plane. By choosing appropriate dimensions of the structures, the passbands and stopbands of the FSS can be controlled to obtain desired characteristics. With this method, multiple passbands and stopbands of an FSS can be achieved simultaneously. A prototype FSS is designed at the Ka band. The FSS is fabricated and then tested in free space to verify the proposed design. The structure is polarization independent and has a very low insertion loss at around 40 GHz.

WC-1

Linear PA at mm-Wave Band for 5G Application

Bumman Kim, Kyunghoon Moon, Daechul Jeong, Seokhyun Kim, and Junho Shin
Pohang University of Science and Technology, South Korea

A highly linear power amplifier (PA) at Ka-band is implemented in 28-nm bulk CMOS process. Operating at a deep class-AB mode with appropriate 2nd harmonic control circuit, a highly linear and efficient PA is designed at mm-wave band. This PA architecture provides a linear PA operation closer to the saturated power, providing high efficiency. Also elaborated harmonic tuning and neutralization techniques are used to further improve the gain and stability. A 2-stack PA is designed for higher gain and output power than a common source PA. Additionally, the memory effect of the PA is suppressed to increase the video bandwidth in the GHz range. This amplifier is quite suitable for 5G application.

1110
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1130

HL-7

Design of Fourth-Order Dual-Band Superconducting Filter Using Dual-Mode Resonator

Baoping Ren[1,2], Haiwen Liu[1], Pin Wen[1,2], Xuehui Guan[1], Zhewang Ma[2]
[1]East China Jiaotong University, China
[2]Saitama University, China

A compact dual-mode hairpin ring resonator (HRR) is proposed to implement dual-band superconducting bandpass filter (BPF) in this paper. Non-coupled and controllable dual-mode resonant characteristics of the proposed HRR are analyzed. Moreover, HRR can be easily extended to high-order filter design because of its unique structural characteristics. For demonstration, a fourth-order dual-band superconducting BPF is designed by using four coupled HRRs. Coupling structure for the adjacent HRRs with inverse orientation is used to excite multiple transmission zeros for high selectivity. The finally obtained fourth-order dual-band filter operating at 1.9 GHz and 2.6 GHz has desired frequency responses and compact size.

WC-2

High Efficiency Power Amplifiers for 5G Wireless Communications

Anh-Vu Pham, Duy P. Nguyen, and Mohammad Darwish
University of California, United States

We present several design techniques to achieve high efficiency and linear power amplifiers in the millimeter-wave frequencies. We will first review the performance of power amplifiers in different semiconductor process technologies at millimeter-wave frequencies. We will discuss the design, implementation and performance of stacked-FET power amplifiers, Doherty power amplifiers and linearization techniques to achieve high efficiency and linearity in millimeter-wave frequencies. The presented power amplifiers have applications in the 5G wireless communications.

1130
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1150

WC-3

A 38GHz 27dBm Power Amplifier In Enhancement Mode GaAs PHEMT Technology

Hamed Alsuraisry[1], Teng-Yuan Chang[2], Jeng-Han Tsai[3] , Tian-Wei Huang[2]
[1]King Abdulaziz City for Science and Technology, Saudi Arabia
[2]National Taiwan University, Taiwan
[3]National Taiwan Normal University, Taiwan

This paper presents a 38 GHz power amplifier for the fifth generation mobile networks (5G) using 0.15 µm enhancement mode (E-mode) GaAs pHEMT technology. This proposed 3-stage PA consists of two driver stages, and one power stage with combining four power devices. It has 19.3 dB small signal gain and can achieve a saturated output power (Psat) of 28.1dBm and 1-dB compression output power (OP_{1dB}) of 27.1 dBm with peak power-added efficiency (PAE) of 28% under 4V supply voltage. This chip occupies an area of 3.75 mm^2.

1150
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1210

WC-4

A Review of Recent Power Amplifier IC

iSwee Liu, Kaixue Ma, Shouxian Mou, and Fanyi Meng
University of Electronic Science and Technology of China, China

This paper gives a brief and concise discussion on latest research of RFIC power amplifier (PA) designs, showing the frontier state-of-the-art developments, and then present our PA designs and some typical newest designs in expertise area with three technologies, a.k.a CMOS, SiGe, and III-V semiconductor. At last, three research hotspots and research trends about on chip PA are summarized and discussed.

Design of mm-Wave Transmitter and Receiver for 5G

Jixin Chen, Weiquan Lin, Pinpin Yan, Jun Xu, Debin Hou, Wei Hong
Southeast University, China

Millimeter wave compact RF transmitter and receiver for 5G communication system are designed in this paper, which could be typically applied in massive MIMO system of 16 channels. The transmitter and receiver are designed using multilayered structure and highly-integrated chips to decrease the module size. The antenna feeding transition structure are designed using electromagnetic field simulation software, and integrated in RF module. The size of fabricated RF modules is 2cm*2cm. IF and power supply circuits are also designed separately for both of them to support the RF array with 16 channels configuration. Performance of single channel transmitter and receiver are measured which could be applied in Q-band millimeter wave massive MIMO system.

1230 ~ 1400

Lunch (Industrial Talk 2)

Room: 2421, 2/F, Li Dak Sum Yip Yio Chin Academic Building, CityU

Best Paper Competition (Poster Session)

Room: 2419, 2/F, Li Dak Sum Yip Yio Chin Academic Building, CityU

Student Paper Competition (Poster Session)

1400 ~ 1500

PS-1

Phase Locked Loop with Spur Reduction Using Frequency Expansion Technique

Wen-Cheng Lai, Sheng-Lyang Jang, Kei-Wu Lu, Ho-Chang Lee and Yen-Jung Su
National Taiwan University Science and Technology, Taiwan

This letter proposed a 1.8V phase locked loop (PLL) using frequency expansion technique. By utilizing pulse interpolation, the proposed architecture is capable of suppressing high-order harmonics of the reference spur as well as fundamental spur. In the implementation, a four-stage pulse interpolator achieves 6-dB additional spur suppression. The PLL was fully integrated in 0.18-μm CMOS technology, and it occupies 812.6μm × 877μm active chip area for millimeter-wave active devices application.

PS-9

Development of a 0.85 THz Nb-AlN-NbN Superconductor-Insulator-Superconductor Mixer

Ming Yao[1,2,3], Jing Li[1,2], Dong Liu[1,2,3], Shaoliang Li[1,2,3], Shengcai Shi[1,2], Pavel Dmitriev[4], Michael Fominsky[4], and Valery Koshlets[4]
[1]Purple Mountain Observatory, CAS, China
[2]Key Laboratory of Radio Astronomy, CAS, China
[3]University of Chinese Academy of Sciences, China
[4]Kotel'nikov Institute of Radio Engineering and Electronics, RAS, Russia

China is planning to build a 5-m THz telescope named DATE5 at Dome A in Antarctica. The telescope will operate in 0.85 THz and 1.5 THz frequency bands. A waveguide superconductor-insulator-superconductor (SIS) mixer is developed for the 0.85 THz frequency band by utilizing parallelconnected tunnel junctions (PCTJ) with Nb/AlN/NbN trilayer and NbTiN/SiO2/Al microstrip tuning circuit on quartz substrate. Its frequency response is measured by a Fourier-transform spectrometer (FTS), showing an FWHM frequency coverage of 762-925 GHz. The measured uncorrected double sideband (DSB) receiver noise temperature is approximately equal to 450 K at 840 GHz. With the vacuum window and beamsplitter losses corrected, the receiver noise temperature is less than five times the quantumlimited noise. Detailed mixer design and measurement results will be presented.

1400
~
1500

PS-2

Multiport Microstrip Grid Array Antenna

Yueping Zhang
Nanyang Technology University, Singapore

This paper first summarizes the research and development of microstrip grid array antennas for millimeter-wave radio and radar applications over the recent years. Then the paper describes multiport microstrip grid array antennas to explore their use in multi-input and multi-output (MIMO) systems. Particular emphasis is given to the multiport excitation and isolation performances.

PS-10

Experimental Characterization of Terajet Generated from Dielectric Cuboid under Different Illumination Conditions

Hai Huy Nguyen Pham[1], Shintaro Hisatake[1], Tadao Nagatsuma[1], Igor Vladilenovich Minin[2], and Oleg Vladilenovich Minin[3]
[1]Osaka University, Japan
[2]National Research Tomsk Polytechnic University, Russia
[3]National Research Tomsk State University, Russia

The terajet, which is the generation of a jet in the terahertz (THz) frequency band (0.1 THz-10 THz), has attracted significant research interest owing to its subwavelength hotspot that can be exploited in THz imaging applications. To date, the generation of the terajet from a dielectric cuboid has been studied and verified under planar incidences. In practical applications of high-resolution THz imaging, it is essential to take into consideration the alignment of the cuboid, as well as the efficient use of the THz power. Here, we experimentally study the generation of the terajet under different oblique and compressed incidences, in order to verify the characteristics of the terajet, such as the position, direction, and full width at half maximum (FWHM) properties. We discover that the terajet can be generated under compressed incidence. The output angle of the terajet under oblique incidence is linear and identical to the input angle of the incident beam. The position of the generated terajet is varied within two wavelengths. The FWHW below one wavelength was maintained under those illumination conditions. Consequently, the cuboid can function as a novel focusing device, which can enhance the resolution by simply placing it in the imaging system with a flexible alignment.

PS-3

Compact Dual-Frequency Antenna for 2.4/60 GHz Applications

Yu-Xiang Sun[1], Kwok Wa Leung[1], and Jun-Fa Mao[2]

[1]City University of Hong Kong, Hong Kong SAR

[2]Shanghai Jiao Tong University, China

A compact dual-frequency antenna with two-port excitation and large frequency ratio is presented. It consists of a circularly-polarized (CP) microstrip patch antenna at 2.4 GHz and a linearly-polarized (LP) substrate-integrated cylindrical dielectric resonator antenna (DRA) at 60 GHz, resulting in a large frequency ratio of as high as 25. The two antenna parts are designed on a single substrate, giving a very compact structure. Slot-coupled source and probes are used to excite the upper-band DRA and the lower-band patch antenna, respectively. ANSYS HFSS was used to simulate the S-parameters, radiation patterns, antenna gains, and axial ratio (AR) (patch antenna part only) of the two antenna parts. The lower-band patch antenna has an impedance bandwidth of 17.3% and AR bandwidth of 15.3%, whereas the upper-band has an impedance bandwidth of 13.15%.

PS-11

A Millimeter-Wave Sequential Power Amplifier

Guansheng Lv, Wenhua Chen, and Zhenghe Feng

Tsinghua University, China

In this paper, we present a millimeter-wave sequential power amplifier (SPA) at the frequency of 26GHz for the first time. The proposed SPA consists of a 3dB power divider, two GaAs power amplifier chips acting as the main and peaking amplifier respectively, and an 8dB output coupler. Measurement results show 6dB back-off efficiency of 18.5% and peak output power of 24.4dBm at 26GHz. The frequency response from 26GHz to 27GHz is also given, and 6dB back-off efficiency better than 18% is achieved from 26GHz to 27GHz.

1400
~
1500

PS-4

Design of an Ultra-wideband and Highly-directive Photoconductive THz Vivaldi Antenna

A. Dhiflaoui[1], H. Rmili[1,2], O. Boularess[1], A. Yahyaoui[1,3], T. Aguili1, and R. Mittra[2,4]
[1]University of Tunis El Manar, Tunisia
[2]King Abdulaziz University, Saudi Arabia
[3]University of Jeddah, Saudi Arabia
[4]University of Central Florida, United States

This paper presents the design of THz Vivaldi Antenna operating in the frequency band of 0.1-6 THz. An optimized design of the antenna is developed by using the CST software to realize an ultra-wideband impedance match, which ranges from 0.7 to 6 THz, as well as a high directivity level, which varies from 3.8 dBi at 2.5 THz to 7.8 dBi at 6 THz. The antenna gain Gmax is found to be -1.6 dBi at 5.5 THz its efficiency ηmax is 16.3 % at 5.25 THz, both of which are relatively low because of metallic and dielectric losses.

PS-12

Focused Array Antenna with 2-D Steerable Focus

Peng-Fa Li, Shi-Wei Qu, Yuan-Song Zeng, and Shiwen Yang
University of Electronic Science and Technology of China, China

A microstrip array antenna with near-field focused beam is presented in this paper, which is composed of eight series-fed and frequency-scanned linear arrays. The array focus can be scanned on the designed focal plane by frequency and through phase control. This array can be used in near-field fast scanning systems, with a low cost.

1400 ~ 1500

PS-5

Millimeter Wave Antenna Array Based on Dielectric-Filled Waveguides

Juha Ala-Laurinaho, Vasilii Semkin, Henri Kähkönen, Viikari Viikari, and Antti V. Räisänen
Aalto University, Finland

This paper presents components based on metallic dielectric-filled waveguides (DFWG) for antenna arrays. Air-filled waveguide feeding networks have low losses but the spacing between the elements of the array cannot be half-a-wavelength which is required for the grating lobe free radiation patterns. By filling the waveguides with dielectric material, the physical dimensions can be decreased. Three prototypes are developed for the lower E-band (71-76 GHz): a transition from DFWG to the standard WR-12 waveguide, a single antenna element based on the DFWG, and a 1x4 linear antenna array. The prototypes are manufactured and measured. The measured insertion loss of the structure with two transitions is 1.3-2 dB at the desired frequency range. The measured realised gain for the single element is 7-9 dBi at the desired band.

PS-13

IR-Fresnel Zone Plate Lens acting as THz Antenna

Alicia E. Torres-García, Bakhtiyar Orazbayev, Iñigo Ederra, Ramón Gonzalo
Universidad Pública de Navarra, Spain

A Fresnel Zone Plate Lens designed for the Mid-IR is modified for acting as a THz Antenna. This proposal is the base for a dual band detector consisting of a Silicon (Si) substrate with a quasi-spiral antenna detector working at THz frequencies which acts also as a modified Fresnel Zone Plate Lens for an IR detector. The focal properties of the proposed lens have been studied numerically, and its behavior as a submillimeter wave receiver has been demonstrated by a 3D full-wave simulator.

PS-6

Double-Polarization Frequency Selective Rasorber Based on Cross-Frame and Circle Ring Slot Arrays

Xin Xiu, Ye Han, Wenquan Che, and Wanchen Yang
Nanjing University of Science and Technology, China

A novel double-polarization frequency selective rasorber is presented. Based on the equivalent circuit model, two absorption bands are created at both sides of a transmission window. Cross-frame elements loaded with resistors is employed to provide the window in passband as well as the absorbing characteristic in stopband, meanwhile circle ring slot arrays with lossless characteristic is used to match the impedance of the lossy FSS layer. A simple structure is obtained by combining these two elements. The simulation results indicate that insertion loss of 0.35 dB can be obtained at 5.25 GHz and a bandwidth of 101% for the reflection less than 10 dB is achieved under normal incidence.

PS-14

Wide-Angle Beam Scanning Reflectarray Antenna Design Using Phase Matching Method

Geng-Bo Wu[1], Shi-Wei Qu[1], and Chi Hou Chan[2]
[1]University of Electronic Science and Technology of China, China
[2]City University of Hong Kong, Hong Kong SAR

In this paper, a multi-focus phase matching method is presented for the design of wide-angle beam scanning reflectarray antenna with mechanical steering. A single-layer 16×16-element reflectarray antenna with variable-size square patch elements operating at 12GHz has been designed utilizing the introduced optimization technique. Numerical results show that the gain variation less than 2dB is achieved across the scan coverage from -45° to +45° by mechanically rotating the feed antenna. Meanwhile, the simulated side lobe level (SLL) below -15dB and -13dB is also observed when the beams are scanned to±30° and ±45°, respectively.

1400
~
1500

PS-7

Tunable perfect absorber for bio-sensing

Luigi Bibbò, Qiang Liu, Mi Lin, Qiong Wang, and Zhengbiao Ouyang
Shenzhen University, China

In this work we have studied a structure based on Localized Surface Plasmon Resonance$(LSPR) constituted by spherical gold nanoparticles in which a substance with high electro-optical properties has been inserted to verify its ability to monitor the presence of biomolecules. The study was conducted using one of FEM simulation tool verifying the optical responses to vary the sizes of the elements of the structure and the refractive index of the layer sandwiched. The results showed high sensing performance making it a potential biosensor.

PS-15

Low-Profile Dipole Array Fed Transmitarray

Peng-Yu Feng, Shi-Wei Qu, and Shiwen Yang
University of Electronic Science and Technology of China, China

The high profile of the space-fed antennas is the main restriction for practical applications. Traditional design method to pursue high compactness of this kind of antenna is to decrease the focus-to-diameter ratio (F/D), but suffers from performance degradation. To address this issue, a small dipole array is chosen as the feed in our design. By employing conjugate field matching (CFM) technology, the small feed array can effectively excite the transmitarray with a significant reduction of the profile. Compared to an identical transmitarray excited by a traditional horn, although 0.33 dB gain drop is suffered, the profile of the whole antenna is reduced by almost two thirds. Finally, the simulated results of the presented model confirm the feasibility of designing a low-profile dipole array feed transmitarray.

1400
~
1500

PS-8

Compact, Omni-Directional, Circularly-Polarized mm-Wave Antenna for Device-to-Device (D2D) Communications in Future 5G Cellular Systems

Wei Lin and Richard W. Ziolkowski
University of Technology Sydney, Australia

A simple, compact, omni-directional, circularly-polarized (CP) millimeter-wave antenna for Device-to-Device (D2D) communications in the next generation (5G) cellular systems is reported. It is a CP omni-directional antenna operating at 28 GHz for mobile terminals. The antenna combines a vertical electric monopole element with four magnetic elements to coherently excite parallel electric and magnetic dipoles. This combination generates the omni-directional CP radiation. The overlapping -10-dB impedance and 3-dB axial ratio (AR) bandwidth is from 27 to 28.5 GHz, which covers the 28 GHz frequency band proposed for 5G mobile cellular networks (i.e., from 27.5 to 28.35 GHz). The antenna has an omni-directional radiation pattern at 28 GHz whose peak realized RHCP gain is 2.08 dBic and whose 3-dB AR beamwidth is wide, from elevation angles 3° to 136°. Mass production of the antenna is possible by PCB manufacturing technologies. The overall size is 3.44 mm × 3.44 mm × 1 mm (ka = 1.1017). Consequently, it could be embedded in many current popular, smart wireless devices such as cell phones, laptops, digital watches, and smart glasses as well as their future versions for operation in 5G cellular networks.

PS-16

Subreflectarrays for Ring-Focus Reflector Antenna

Chao Ma, Shi-Wei Qu, and Shiwen Yang
University of Electronic Science and Technology of China, China

In this paper, a design that utilizes subreflectarrays for ring-focus reflector antenna is proposed. A 0.3 m parabolic reflector which operates at 23 GHz is chosen as a main reflector in ring-focus reflector antenna, and a 50 mm diameter circular array consists of 68 elements is designed to emulate a metal subreflector, using a method presented in this paper. Simulation results of the reflector demonstrate a good availability of the presented design about utilizing reflectarrays as subreflector for ring-focus reflector antenna.

1500 ~ 1520

Tea Break

Room: 2505, 2/F, Li Dak Sum Yip Yio Chin Academic Building, CityU

Millimeter-Wave and THz Communications & Millimeter-Wave Active Devices and ICs

Session Chair: Youjiang Liu

1520 ~ 1540

MB-1

A 32GS/s 8-bit Time-Interleaved ADC System with 16GHz Wideband RF Front-End and Embedded Fully-Blind Digital Calibration

Youjiang Liu, Dahai Chen, Guifu Zhang, Niantong Du, and Yongtao Qiu
China Academy of Engineering Physics, China

This paper implements a time-interleaved ADC (TIADC) system with embedded 16GHz wideband track-hold (T/H) front-end. The TI-ADC is characterized with 32GS/s total sampling rate, by time-interleaving 16-channel sub-ADCs with 2GS/s individual sampling rate and 8-bit resolution. A digital blind post-calibration technique based on frequency domain analysis of the TI-ADC output is proposed, which is characterized using a comprehensive TI-ADC behavioral model. The model takes into account the timing, gain and offset mismatch errors. All the three mismatch errors are characterized using the specific basis functions. Without the need of training sequence, a blind calibration model is developed during an iterative loop to extract the mismatch errors, which are subtracted from the measured TI-ADC output successively. A maximum of 3-bit improvement for the effective number of bit (ENOB) has been achieved, resulting in a 6.5 bit ENOB at low-end frequency and 4.5 bit ENOB at high-end frequency. Further, the proposed technique is also effective to wideband signal's sampling.

1540 ~ 1600

MB-2

Low Power Voltage Control Oscillator for Wireless Communications Application

Wen-Cheng Lai, Sheng-Lyang Jang, Rei-Ru Liu, Ho-Chang Lee, and Yen-Jung Su
National Taiwan University Science and Technology, Taiwan

This paper present a low power voltage control oscillator (VCO) and implemented in tsmc 0.18 μm BiCMOS process, which using current-reuse technique to support low power consumption from supply voltage 1.3V. The proposed circuit measured as tuning range of 9.02~10.46 GHz at power consumption is 2.6 mW. The measured phase noise is -111.2 dBc/Hz at offsets 1 MHz of center frequency 10.27 GHz. The chip size is 0.467 × 0.789 mm^2 for millimeter-wave active devices application.

1600 ~ 1620

MB-3

A 18.6 GHz Locking Range, 60 GHz Band Varactor-Tuned Injection Locked Frequency Divider in 65 nm CMOS

Masafumi Kazuno, Mizuki Motoyoshi, Suguru Kameda, and Noriharu Suematsu
Tohoku University, Japan

A 60 GHz band injection locked tunable dynamic frequency divider has been developed in 65 nm CMOS. By varying the bias voltage of varactor diodes in LC tank circuit of the dynamic divider, the fabricated CMOS RFIC performs the widest operational frequency range of 18.6 GHz (relative bandwidth of 34.5 %) at VDD = 1 V and the highest FoM at VDD = 0.5 V in 60 GHz band.

1620 ~ 1640

MB-4

A Compact Transistor Based Analog Predistorter Using a Slow Wave Coupler

Qi Cai[1], Wenquan Che[1], Kaixue Ma[2]
[1]Nanjing University of Science and Technology, China
[2]University of Electronic Science and Technology of China, China

A compact transistor based analog predistorter (APD) using a slow-wave coupler is proposed. Compared with previously published work in [7], 72% size reduction is realized for the proposed slow-wave coupler, while 49.1% size reduction is achieved for the total APD. One prototype is designed and fabricated for verification. The simulated results of the APD show the insertion loss of 0.5 dB at 2.4 GHz with a return loss of -8.4 dB and -14.5 dB at the input and output port, respectively. Under large signal simulation, the proposed APD shows a maximum gain enhancement of 2 dB at the input power of 26 dBm, which perfectly compensates the gain compression of the main PA at this power level. The simulated output 1dB gain compression point (P1dB) of the main PA is increased from 36 dBm to 40 dBm under CW signal with the proposed APD.

1640
~
1700

MB-5

Two-Dimensional Cavity-Backed Angled-Dipole Array Antenna for 28-GHz Band

Son Xuat Ta and Ikmo Park
Ajou University, South Korea

This paper presents a high-gain low-sidelobe two-dimensional cavity-backed angled-dipole array antenna with 64 antennas in an 8 × 8 square grid for 28-GHz applications. This antenna yields broadband characteristics and similar 3-dB beamwidths in the E- and H-planes, and it is chosen for stable operation in a two-dimensional array environment. A nonuniform power distribution is used to excite the array to achieve a low sidelobe level (SLL) in the azimuth planes. The proposed array showed similar scanning performance in the E- and H-planes. It achieved gain exceeding 20.0 dBi and SLL below -18.5 dB for scanning angles up to 40°.

1830
~
2200

Banquet

26 May, 2017 (Friday)

Room: 2505, 2/F, Li Dak Sum Yip Yio Chin Academic Building, CityU
Wireless Power Transmission and RF Energy Harvesting
Session Chair: Hucheng Sun

Room: 2510, 2/F, Li Dak Sum Yip Yio Chin Academic Building, CityU
Millimeter-Wave and THz Sensing, Sub-millimeter-wave and THz Technologies & Millimeter-Wave Antennas and Passive Devices
Session Chairs: Sheng-Cai Shi, Kaixue Ma

0850 ~ 0910

HS-1

Frequency Optimization of an Implantable Antenna for Far-field Wireless Power Transmission

Changrong Liu[1], Jun Wang[2], Xinmi Yang[1], and Xueguan Liu[1]
[1]Soochow University, China
[2]Beijing Electro-Mechanical Engineering Institute

Optimal operating frequency is studied in this paper to enhance the wireless link efficiency. Frequency effect is analyzed for far-field wireless power transmission. The electrical properties of human muscle is studied to calculate attenuation constant of human tissue and field reflection loss at muscle-to-air interface. The gain of an implantable antenna is estimated after assuming incident plane-wave propagation. Safety considerations are fully considered to establish equivalent isotropic radiated power of external device. The received power is calculated by indoor line-of-sight propagation model. Thus the optimal frequency can be achieved by the maximum received power versus frequency.

MC-1

Development of Electronic Subsystems for a Terahertz Wireless Link

Jose Manuel Pérez Escudero, Iñigo Ederra Urzainqui, and Ramón Gonzalo García
Universidad Pública de Navarra, Spain

In this paper, a very wide bandwidth frequency tripler and fourth harmonic mixer for a wireless communication link at 300 GHz have been designed. An anti-parallel configuration of Schottky diodes has been used for both devices. The fourth harmonic mixing configuration is a good solution when it is difficult to have enough Local Oscillator (LO) power to pump the diodes whereas frequency increases. Conversion Loss (CL) of the tripler is around 15 dB for 65 GHz bandwidth in which the best value is 12 dB for 318 GHz. For the fourth harmonic mixer, the CL obtained is around 18 dB within 41 GHz bandwidth. The best value is 10.2 dB for 301 GHz.

0910
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0930

HS-2

Electrically Small Array for Microwave Energy Harvesting

Shen-Yun Wang and Peng Xu
Nanjing University of Information Science & Technology, China

In this paper, we propose a three-dimensional antenna resonator consisting of a pair of inverted L-shaped wires sharing a common part, a continuous metallic ground slab, and a coaxial port loaded with a lumped matching resistor to mimic the input impedance of a rectifier. Such a resonator array can function as an efficient RF energy receiving aperture in the long-distance wireless power transmission system. Unlike the conventional receiving array, where the distance between adjacent elements is half wavelength to reduce the mutual coupling, here the distance between the receiving elements is electrically very small to achieve good impedance matching between free space and energy output port. An equivalent circuit model is proposed to explain the energy capture mechanism. Simulation results show that near unity energy capture efficiency at resonant frequency is obtained under incidence of both normal and oblique incident wave.

MC-2

A Simple Quasi-optical Design for LO Coupling at THz Bands

Jie Hu[1, 2, 3], Dong Liu[1, 2], Wei-Tao Lv[1, 2, 3], Jing Li[1, 2], Z. Lou[1, 2], Sheng-Cai Shi[1, 2]
[1]Purple Mountain Observatory, China
[2]Key Lab of Radio Astronomy, CAS, China
[3]University of Chinese Academy of Sciences, China

A simple quasi-optical design for LO coupling in the quasi-optical heterodyne system has been described. Due to the limited LO power available at THz bands, it is of great importance to achieve high efficiency LO power coupling to the mixer. Two elliptical mirror have been employed to couple the LO power to the SIS mixer. Measurement at nearly 500GHz shows such configuration is sufficient to pump a long junction SIS mixer.

0930
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0950

HS-3

Wireless Power Transmission to a Device Shielded by Unknown Electromagnetic Media

Hucheng Sun, Wen Geyi, and Xiao Cai
Nanjing University of Information Science and Technology, China

This paper presents a method to realize wireless power transmission to a device shielded by unknown electromagnetic media based on measurement. An antenna array is used to transmit the power to the receiving device. The transmitting array elements and receiving device constitute a multi-port network, and can be characterized by the S-parameters. The power transmission efficiency can be expressed in terms of the S-parameters, and its maximum possible value can be calculated. Also, the corresponding excitation distribution for the transmitting elements can be obtained. With the calculated excitation distribution, a feeding network can be designed to feed the transmitting elements and the whole wireless power transmission system can be then constructed. An example is presented to demonstrate the method.

MC-3

A New Method and Transceiver Architecture Dedicated to Continuous Detection of Very Small Metallic Object

Pape Sanoussy Diao, Thierry Alves, Benoit Poussot, Martine Villegas
Université Paris-Est, France

In this paper, we propose a multi-band impulse detection technique to improve the detection of small objects. The choice of frequency bands is based on millimeter ultra-wideband (UWB) normalization and is related to the radar cross section of the objects to be detected. A nomadic impulse architecture associated with the detection principle is proposed. By using two orthogonal polarizations, our results show that multi-band impulse method offers better performances in terms of continuous detection surface compared to conventional single band detection system.

0950
~
1010

HS-4

A High-Gain Rectenna Based on Grid-Array Antenna for RF Power Harvesting Applications

Yi-Yao Hu[1], Hao Xu[1], Hucheng Sun[2], and Sheng Sun[1]
[1]University of Electronic Science and Technology of China, China
[2]Nanjing University of Information Science and Technology, China

A novel rectenna based on the grid-array antenna is presented in this paper. The grid-array antenna provides the feasibility to tilt the radiation beam. Two isolated feed points are designed in the grid-array antenna so as to generate two different beams separately. In this way, the rectenna can harvest more wireless RF energy from different directions. Finally, a prototype is fabricated and measured. Under the power density of 1μW/cm^2, it can produce over 50 μW dc power when the incident angle of incoming wave ranges from −10° to 10° at the E-plane.

MC-4

3D-Printed Millimeter Wave Lens Antenna

Ravi Kumar Arya[1], Shiyu Zhang[2], Yiannis Vardaxoglou[2], Will Whittow[2], and Raj Mittra[3,4]
1The Pennsylvania State University, United States
[2]Loughborough University, United Kingdom
[3]University of Central Florida, United States
[4]King Abdulaziz University, Saudi Arabia

In this work, we present a flat lens design using the Dial-a-Dielectric (DaD) and 3D-printing technique to realize the materials that are not available off-the-shelf. We design the proposed flat lens and compare its performance with that of the ray−optics (RO)−based lens. We find from the results that both designs show comparable performance.

HS-5

High-Efficiency Microwave Rectifier with Wide Operating Power Range

Zhi-Xia Du and Xiu Yin Zhang
[1]Purple Mountain Observatory, China
[2]Key Lab of Radio Astronomy, CAS, China

Wireless power transmission (WPT) is a promising technology that can be employed as an alternative power source for electronic circuits. Actually, the receiving power generally cannot remain constant due to different transmission environment and distance. The variation of the input power levels leads to the diode impedance change, and then causes impedance mismatch and rectifier performance degradation. In this work, two kinds of network have been placed between the input port and the rectifiers, extending the operating power range. Firstly, a branch-line coupler is used as a power recycling network to improve the matching performance and conversion efficiency when the input power varies. In this case, two types of rectifiers can be designed by using the branch-line coupler. Both the two rectifiers include two identical sub-rectifying circuits and a branch-line coupler. The isolation port of the coupler in the proposed Type I rectifier is directly connected to the ground, in order to re-inject the reflected power back to the sub-rectifiers for recycling. As for that in the proposed Type II rectifier, it is connected to the third rectifier, which can rectify the reflected power. Thereby, the power reflected from the two sub-rectifiers due to impedance mismatch can be reused by the two types of proposed rectifier. The RF-dc conversion efficiency can be improved and the operating power range for high

MC-5

A Low Loss Self-Packaged Quasi-Lumped-Element High Pass Filter Using SISL Technology

Zonglin Ma, Kaixue Ma, and Fanyi Meng
South China University of Technology

This paper presents a low loss self-packaged quasi-lumped-element high pass filter (HPF) based on substrate integrated suspended line (SISL) technology. The HPF is composed of double metal layer spiral inductors and interdigital capacitors. And the dielectric loss for the filter elements is further reduced through hollowing the support substrate. The HPF also has advantages of self-packaging, low loss, compact size, and low cost by using SISL technology.

efficiency can be widened. Moreover, a complex impedance compression network (ICN) is also proposed and applied to the design of rectifying circuits for extending operating power ranges. The proposed ICN is connected to the microwave input of two parallel sub-rectifiers. It reduces the variation range of the rectifier input impedance which changes with input power. Thus the loss due to impedance mismatch is therefore reduced and subsequently high efficiency can be obtained over a wider input power range. Compared with the resistance compression network (RCN), the proposed ICN is able to compress the variation range of the complex impedance rather than that of the resistive load, featuring design flexibility. For demonstration, the ICN is applied to the design of single-band and dual-band microwave rectifiers. Theoretical analysis and performance comparison are carried out. The results indicate that the proposed topologies are able to realize high efficiency with wide input power dynamic range.

1030 ~ 1050

Tea Break

Room: 2505, 2/F, Li Dak Sum Yip Yio Chin Academic Building, CityU

Novel Microwave and Millimeter-wave Substrate Integrated Antenna and Array Technology

Session Chair: Yujian Cheng

1110 ~ 1130

YC-2

Substrate Integrated Focused Multibeam Antenna Based on the Modified Rotman Lens

Yu Jian Cheng, and Fei Xue
University of Electronic Science and Technology of China, China

In this paper, a modified substrate integrated waveguide (SIW) Rotman lens is proposed to feed several SIW slot array antennas in order to generate multiple focal points. This modified SIW Rotman lens, as a focused beamforming network (BFN), consists of eleven input beam ports and fifteen output array ports. Its phase shifting network is modified to satisfy the requirements of beam focusing and scanning. The focal point of the integrated multibeam antenna can be changed when it is excited at different input port.

1130 ~ 1150

YC-3

Planar Substrate Intergrated Circular Polarized Antenna for Q-band Wireless Communications

Yan Zhang and Wei Hong
Southeast University, China

A planar substrate integrated circular polarized (CP) antenna is proposed using a pair of wideband ±45° slot radiators for Q-band wireless applications. The introduced radiator is a modified top-wall 45° slot on the broadside of a substrate integrated waveguide (SIW), and the SIW is terminated with a ±45° short-circuit end together with a pair of inductive via is adopted for impedance matching, both of which contribute to a wideband performance. By connecting a pair of ±45° slots to a 90° SIW directional coupler, a CP antenna is implemented with a wide axial ratio (AR) and impedance bandwidth. The proposed antenna has a wide AR bandwidth of 14% from 42.1 to 48.5GHz with gain>5.5 dBic and S11<-15dB.

1150 ~ 1210

YC-4

Ku-Band Circularly Polarized Leaky-Wave Antenna based on Lateral Sparse Substrate Integrated Waveguide for Satellite Communication

Ming Yang, Cheng Jin, and Meiguo Gao
Beijing Institute of Technology, China

This paper presents a user terminal leaky-wave antenna (LWA) for satellite communication system in Ku-band. The motivation is to propose a low-profile broadband high-gain receiving antenna with beam-scanning and circular polarization features. The antenna is based on a lateral sparse substrate integrated waveguide, which is constructed by a microstrip line shorted with two rows of sparse and abundant periodic metallic via-holes on both sides with periodic transverse slots etched on the upper side. To achieve good circularly polarized radiation and compact configuration, non-uniform SIW width configuration is used to realize effective phase shift over the relative broadband. Measured results show that the antenna presents experimentally expected broadband matched impedance with return loss $|S_{11}| > 10$ dB from 15.4 GHz to 19 GHz. The measured radiation pattern exhibits continuous frequency-scanning from 35° at 15.5 GHz to 47° at 18 GHz according to the broadside with maximum gain of 12.3 dBic. The measured axial ratio is within 3 dB from 15.9 GHz to 17.2 GHz. Measured results are in good agreement with predicted ones, and it is demonstrated that the proposed structure is a simple and compact candidate of high performance circularly-polarized antenna for satellite communications. Also the beam scanning capability of proposed antenna could find potential applications in inter-satellite communications.

1210 ~ 1230

YC-5

Linear Polarized Substrate Integrated Dielectric Resonator Antennas in Ka Band

Ke Gong, Peng Hu, Zu Cheng Zhang, Bing Jie Deng, Dong Dong Ma, Xue Hui Hu, and You Chao Tu
Xinyang Normal University, China

Three linear polarized substrate integrated dielectric resonator antennas (LPSIDRAs) are briefly reviewed in this paper. These antennas can be implemented with a two-layer printed circuit board (PCB) process conveniently, in which the integrated dielectric resonator is fabricated in the top layer and fed by a compact substrate integrated waveguide (SIW) through a transverse coupling slot within the bottom layer. The prototypes exhibit good radiation performances in Ka band, and the 10-dB bandwidth can be easily extended from around 12% to 25% with stable broadside radiation patterns. These antennas show the advantages of low profile, high radiation efficiency, easy manufacture, etc.

1230 ~ 1400

Lunch

Industrial Talk 1

24 May, 2017 (Wednesday)
1330~1400
8/F, Lau Ming Wai Academic Building, City University of Hong Kong

Session Chair: *Kam Man Shum*

Solid-State Terahertz Sources

by
Eric W. Bryerton
Virginia Diodes, Inc., United States

Abstract
Solid-state sources using diode based frequency multipliers are critical for radio astronomy, atmospheric studies, spectroscopy, as well as many other important scientific applications. VDI shipped its first multiplier based source operating above 1 THz in 2005, generating about 5 uW in the band from 1.3 to 1.35 THz. Since then, VDI and many other groups have worked to improve this technology with great success. However, the needs of the scientific community continue to increase and there is continuous demand for improved power, tuning bandwidth, noise and system reliability. This talk will describe many of the technological innovations that are now used to achieve these goals along with specific recent examples that demonstrate the current capability of this technology, including a 215 GHz varactor source that generates greater than 300 mW and a 2.5 THz source that generates about 5uW in the band from 2.48 to 2.7 THz. Prospects for further improvements and technical challenges and opportunities will be discussed.

Biography
Eric W. Bryerton received his electrical engineering B.S. in 1995 from the University of Illinois and Ph.D. in 1999 from the University of Colorado. He is currently a member of the senior engineering staff of Virginia Diodes, Inc. (VDI). From 1999-2013, he was a research engineer and scientific staff member at the National Radio Astronomy Observatory (NRAO) Central Development Laboratory (CDL) in Charlottesville, VA, where his primary responsibility was the design, development, and production of the local oscillators for all the ALMA (Atacama Large Millimeter Array) receiver bands from 84-950 GHz. From 2012-2013, he also served as the Deputy Director of the CDL and North American Technical Lead for ALMA. Since joining VDI in 2013, Dr. Bryerton has led the development of highly integrated sub-millimeter wave sources and receivers for radiometry, spectroscopy, test and measurement, and new applications.

Industrial Talk 2

25 May, 2017 (Thursday)
1330~1400
8/F, Lau Ming Wai Academic Building, City University of Hong Kong

Session Chair: *Kam Man Shum*

Anritsu Millimeter Wave Measurement Solutions

by
Alex Tao Liu
Anritsu, United States

Abstract
With a foundation afforded by the "Measuring Technologies" accumulated over its history of more than 120 years, Anritsu business expansion has occurred chiefly in the information and communication field. The company's flagship measuring instrument business provides products and services indispensable to the research and development, manufacture and maintenance of millimeter wave communication systems and devices on a global scale. By utilizing patented shockline nonlinear transmission line NLTL technology, Anritsu has launched the most compact millimeter wave band vector network analyzer and spectrum analyzer in the world. In addition, Anritsu is the industry leader for high frequency precision components.

Biography

Alex Tao Liu holds the bachelor degree in telecommunications from Nanjing University of Aeronautics and Astronautics (NUAA) and master degree in telecommunications from Southeast University (SEU) in Nanjing. He has over 10 years of working experience in test and measurement field and he has joined Anritsu Company, US as China Business Development Manager since 2012.

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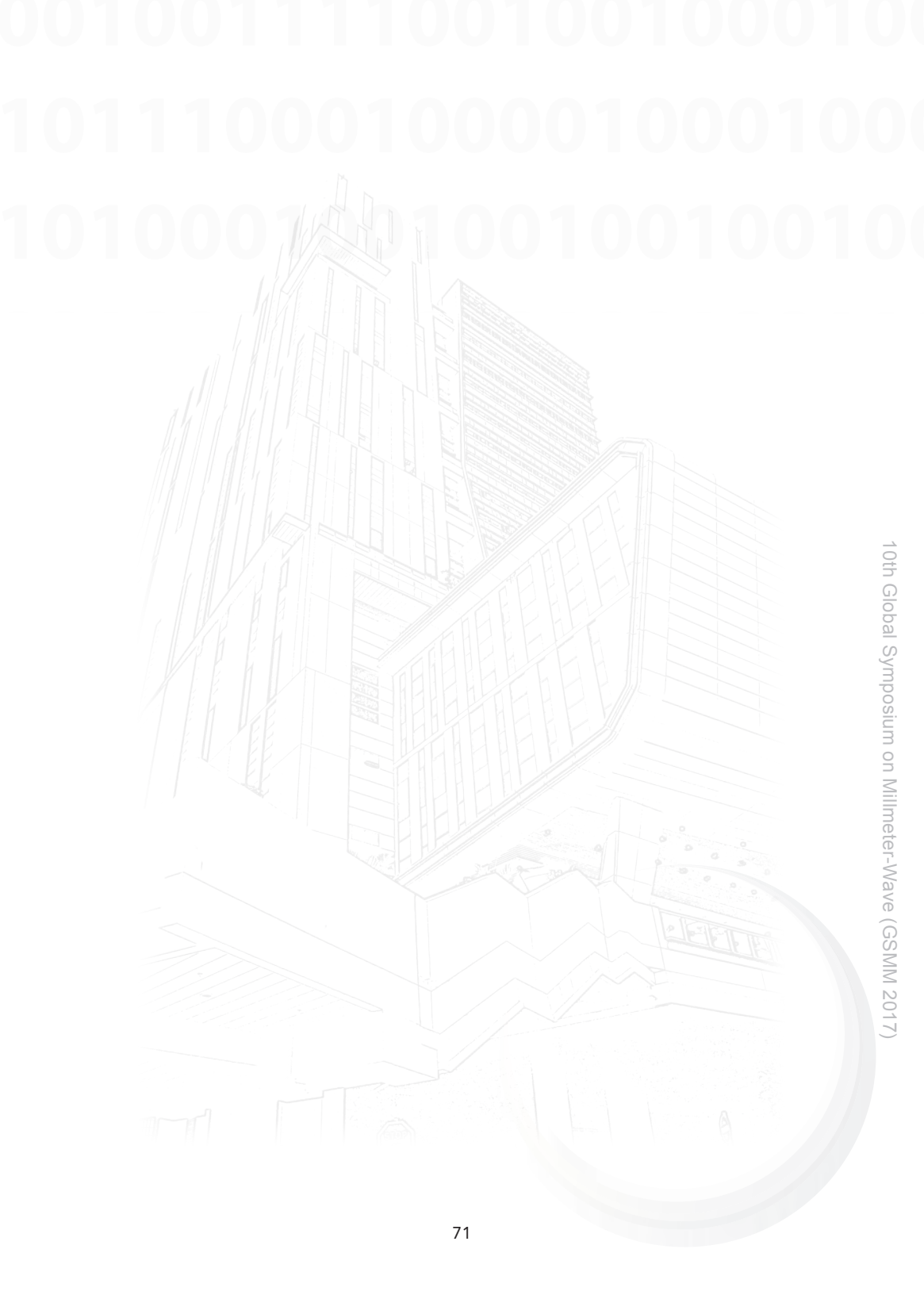

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Dynamic Range (BW=10Hz, dB, typ)	120	100	120	120	120	120	115	115	110
(BW=10Hz, dB, min)	100	120	100	100	100	100	100	100	100
Magnitude Stability (±dB)	0.15	0.15	0.15	0.15	0.25	0.25	0.25	0.3	0.5
Phase Stability (±deg)	2	2	2	2	4	4	4	6	8
Test Port Power (dBm)	10	10	10	6	6	-1	-2	-6	-15

VDI

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